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TIGER-BEETLES.—I.

By E. A. Butler.

ARID, sandy bank, either entirely bare or only scantily covered with vegetation, so that there shall be, not a continuous carpet of verdure, but simply isolated tufts here and there, with bare patches between—a bright sunny morning in late spring or early summer, when the sun's rays are pouring down full upon that bank—these are the conditions of place and time most favourable for observing tiger-beetles in the full play of their activities. Let the observer take his stand at such a spot at such a time, and he will soon become conscious of the rapid, lightning-like dash of some object past him towards the bank, followed by an almost imperceptible thud, but so quick is the movement and so instantaneous the phenomenon, that he may need it repeated several times before he can be quite sure of its reality, and may even then require further scrutiny before he can discover its cause in the rapid movements of these really brilliant, though not very easily detected insects.

Tiger-beetles are among the most active and rapacious examples of the whole order *Coleoptera*, and at the same time some of the handsomest. They constitute a distinct family called the *Cicindelidæ*, and in systematic arrangements stand first amongst the Geodephaga, or carnivorous ground beetles, which again are placed at the head of the whole order. Thus they occupy in systematic zoology a position amongst beetles analogous to that of eagles amongst birds. The only genus represented in this country is the typical one *Cicindela*, of which, again, we possess only four species. Exotic forms are very numerous, and many of them are exceedingly handsome in coloration as well as elegant in form. In general structure the majority of them are so much alike that a description of the commonest English species will be sufficient to make clear the characteristics of the group as a whole.

Our best-known tiger-beetle is called *Cicindela campestris* (fig. 1), and is an abundant insect in all sandy places. Though so common, it is one of the handsomest beetles we possess; above, it is of a bright green colour, which, about the head and thorax, has a little metallic gloss. The microscope, however, effects a great improvement in its appearance; the surface is seen to exhibit a shagreened texture, and in a good light all the little irregularities glitter and sparkle with gorgeous, gem-like tints. Few sights, indeed, are more dazzling in brilliancy than a low-power microscopic view of the fore parts of one of these insects, strongly illuminated as an opaque object. The elytra, or wing covers, are rather flat on the back, with prominent shoulders, and are marked with ten creamy spots, which, in different specimens, vary a good deal, both as to size and distinctness. The colour of the back, too, is variable; sometimes it is of the most intense green, sometimes almost olive-green, and occasionally black. Underneath the insect is, if possible, handsomer than above; the whole under surface is brilliantly polished and of a deep metallic bluish-green, shot here and there with coppery red.

FIG. 1.—CICINDELA CAMPESTRIS. The Common Tiger-Beetle.

In the general aspect of these insects there are many indications of the extraordinary rapacity and agility which characterise them. The mouth-organs and legs naturally exhibit the chief peculiarities. The latter are long and slender, reminding one of the similarly modified organs in a gazelle. They are perfect gems of coloration, for which reason they are frequently mounted as opaque microscopic objects, when, for exquisite range of tints, they vie with that favourite object the iridescent hairs of the sea-mouse. Their coloration is hardly seen to advantage till they are removed from the body, when the brilliant ruby red shading into the characteristic green is easily observed. So slender are they, however, and so small, in consequence, is the compass into which their beauty is packed, that it is quite unperceived by the naked eye unless they are examined closely. And this remark applies almost equally to all entomological specimens; the characteristic peculiarities are so minute, even at the best of times, that a person cannot be said really to have seen what an insect is like without making a close and detailed examination, which will often be the means of correcting first impressions, formed after a mere cursory glance. There is no lesson the entomologist needs more carefully to remember than that close and attentive examination is always necessary, even with the most familiar objects, and whoever ignores this is sure to be perpetually making mistakes. The amateur, especially, in meeting with any insect new to him, should never rest satisfied till he has carefully applied at least a hand lens to all parts of its exterior.

If the structure of the legs is indicative of agility, even to a greater extent is that of the mouth organs suggestive of rapacity. The mandibles (fig. 2) or principal jaw must be, at least to the lower creation, truly terrible instruments. Curved, intensely hard, sharp-pointed, and strongly toothed, they give the beetle a most cruel and ferocious aspect, as they project considerably in front of the head, and they are so large that when closed they cross one another like the

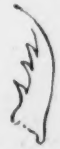


FIG. 2.—MANDIBLE OF TIGER-BEETLE.

opened blades of a pair of scissors. In speaking of an insect's mouth organs, just as of those of a spider, a crab, or a lobster, or any animal allied to these, it is necessary constantly to bear in mind that the jaws are totally different from the parts similarly named in a vertebrate. They are, in fact, external appendages, constituted on the same type as the limbs, though usually very greatly modified in form, and differing in the degree of development of the several parts; their movement also is lateral or transverse—*i.e.*, from the sides towards the middle, never longitudinal, as in a vertebrate. If this be borne in mind, it will be obvious that weapons such as the mandibles of a tiger-beetle are eminently adapted for the *capture* of living prey, but that without some other organs to come to their assistance they would be of small use either for tearing it to pieces or for conveying the fragments to the mouth. No object secured between their tips could be brought near the mouth, for, as they are hinged at the base, and their tips describe the arc of a circle, it would obviously be necessary, in order that this should be practicable, that the length of each mandible should not be greater than half the distance their bases are apart. But this maximum is greatly exceeded in the present instance, so that when closed they cross at about the middle of their length. The difficulty is obviated by means of another pair of so-called jaws, the maxillæ, more complex in structure than the mandibles, but at the same time far weaker; to these, which are placed immediately beneath the mandibles, and are furnished with a pair of jointed appendages, the maxillary palpi, is assigned, in concert with a central hinged plate bounding the mouth opening above, and a similarly placed piece bounding it below, the duty of manipulating the food, assisting to pinch off portions of it after it has been already mangled by the mandibles, and guiding them into the aperture of the mouth. The plate which guards the mouth above is called the labrum (fig. 3), and in these insects is enormously developed, forming a kind of lid lapping over the base of the mandibles to a considerable extent, and as it is of a yellowish white colour, and thus contrasts strongly with the prevailing green of the rest of the body, it forms one of the most striking and conspicuous features of the insect. The piece which bounds the aperture of the mouth below is called the labium, and, like the maxillæ, is furnished with a pair of long palpi fringed with hairs. The combined action of all these organs, which, so to speak, play into one another's hands like the parts of a complicated machine, render it almost impossible that any portions of food should fail to reach their destination.

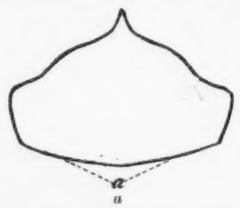


FIG. 3.—LABRUM OF TIGER-BEETLE. *a*. Line of junction with head.

In picturing to ourselves, then, the taking of a meal by this tiger of the insect world, we are not to think of a series of operations like those of its namesake in the vertebrate sub-kingdom, we are not to think of the prey as held down by the fore feet of its captor, while a pair of internal and vertically moving jaws, carrying teeth imbedded in sockets, are tearing it to pieces, the head meanwhile being moved about with the utmost freedom from one side to the other, as the position of the morsel may demand; but we are to imagine the prey secured between two sickle-shaped, external and laterally moving jaws, hinged to a head which, in consequence of the hard and inflexible armature with which it is covered, has but little freedom of movement, and carrying on their inner edges teeth which are not imbedded in sockets, but are simple projections of the substance of the jaws themselves, and while thus held and pinched, we are to imagine it further as played upon by another pair of laterally moving external appendages beneath the jaws, assisted by a central movable plate both above and below, as well as by two pairs of jointed, finger-like palpi, the food being, by the combined exertions of all these organs, gradually reduced to sufficiently small fragments, and passed into the aperture which constitutes the real mouth.

Cicindela campestris is a plucky insect, and if captured, will make sturdy efforts to inflict a wound on its captor by aid of its mandibles; but though these are terrible enough weapons to any unlucky insect that may fall in their way, they are not powerful enough to do harm to human kind, and can only inflict a sharp pinch. In one sense a tiger-beetle is a pleasant thing to hold in the hand, for it emits a powerful and very agreeable scent, which has been variously described as like that of roses, sweetbriar, or crushed verbena leaves; no such description, however, can give an entirely adequate notion of it, and as with most other scents, the only way to understand what it really is like, is actually to smell it. It is rather curious that a carnivorous animal should be pleasantly fragrant; one usually associates odours the reverse of delightful with flesh-eating habits, and most of the other groups of carnivorous beetles fully bear out such a generalisation. A somewhat parallel case, however, is to be found amongst the mammalia, in the civets and genets, which are carnivorous, and are noted for the strong perfume that accompanies them, a perfume so strong indeed as to become almost repulsive, and it may seem not far short of an insult to the tiger-beetle to suggest a comparison. It is another curious coincidence that, as with the tigers and leopards and the rest of the *Felidæ* amongst mammals, we have in these insects an exceedingly handsome coloration associated with the highest development of carnivorous propensities.

(*To be continued.*)

THE NATION'S PURSE.

By ALEX. B. MACDOWALL, M.A.

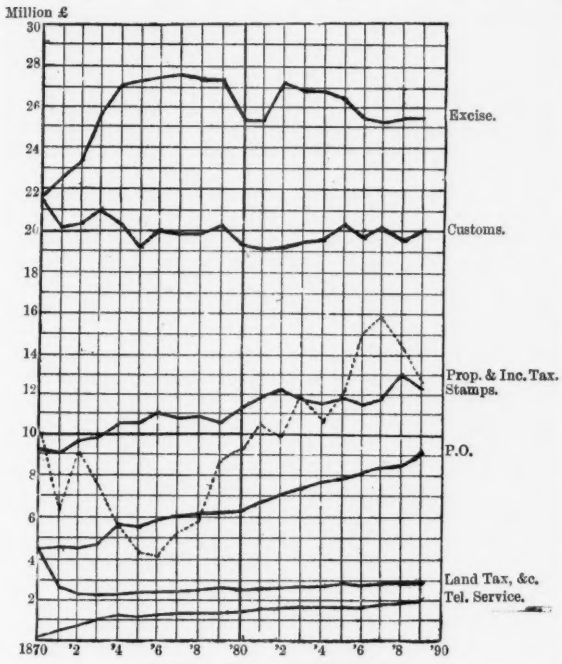
THE graphic method does not seem to have been much applied as yet to the financial statements of the nation. But it is capable of affording a useful *coup d'œil* of the condition of finances in a series of years. We propose to illustrate this month the national revenue and expenditure.

If the average British citizen and voter were required to state off hand how we got our money and how we spent it, in what proportions this or that source contributed to the whole national income, how much we spent on the debt, how much on the army and navy, and so on, and how our income and outlay have varied in the last twenty or thirty years, his answers would, in many cases, we fear, "leave something to be desired" in the matter of precision.

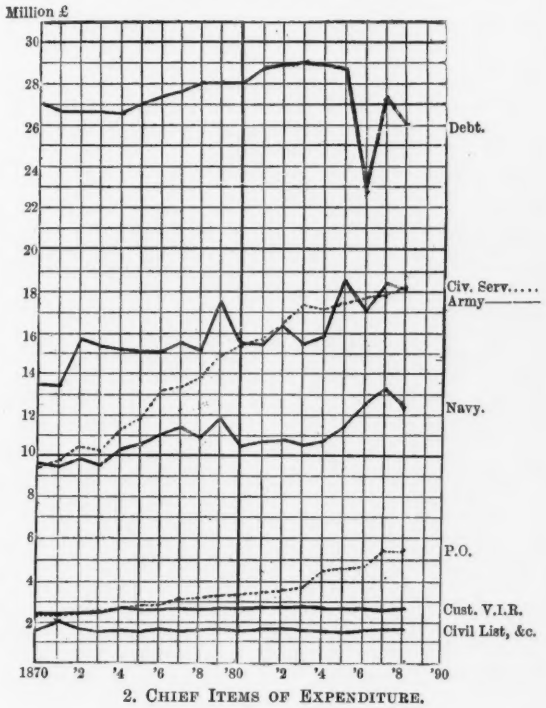
Our two diagrams, attentively considered and fixed in the mind, might possibly help him. The course of a curve, and its relative position among other curves, may be remembered, where long reading or recital of figures leaves comparatively no impression.

These curve pictures show the chief items of revenue and expenditure each year since 1870. The total revenue has risen from 75 to 88 millions; the total expenditure from 68 to 87 millions (roughly speaking). As to the revenue, we may point out that excise is the greatest source,

and note how rapidly the curve rises in the four or five years at the beginning of the period, when there was a striking revival of trade. The great bulk of what the



1. CHIEF ITEMS OF REVENUE.



2. CHIEF ITEMS OF EXPENDITURE.

excise yields each year is, of course, from spirits and beer. Then there are the various licences not only of publicans, &c., but for carriages, dogs, game, male servants, and so on. Of the customs, tobacco yields about one-half; spirits and wine come next, giving about a fourth; then come tea, coffee, various fruits, &c.

Note the wide variations of the property and income tax (dotted curve) and the rise from 1876; also the steady rise of income from the post-office and telegraph service, from stamps, and from land tax and house duty.

Looking now at the second diagram (expenditure), we have first the huge charge of the National Debt, consisting of interest on the "funded" and "unfunded" debt and "terminable annuities." The army and navy curves rise to 18·1 and 12·3 millions respectively. These curves do not show the cost of special military preparations, of which the most notable is represented by the 9 millions voted in 1886; then there was the Egyptian expedition, 3·8 millions, in 1883, the war in South Africa, 3·2 millions, in 1880, &c. The miscellaneous Civil Service curve rises rapidly, the annual amount being about doubled since 1870. The principal objects are here "Law and Justice," and "Education, Science, and Art." The lowest curve relates to charges on the consolidated fund, viz., the civil list, annuities and pensions, salaries, allowances, courts of justice, &c.

This *multum in parvo* graphic method of representation might with advantage, we think, be applied to a variety of the undertakings which involve finance. Thus, it might be interesting to see how the late Metropolitan Board of Works received and spent; and many a harassed ratepayer might welcome a brief and clear vision of how the moneys of school boards, local boards, poor law guardians, and other public bodies, come and go. Once more, one would like to have the finances of certain modern charities thus set forth—enabling one especially to see how much money which should have gone to persons needing to be helped is wasted in quite unnecessary expenses of management.

AN INVERTEBRATE EYE IN THE VERTEBRATE SKULL.

By W. MAWER, F.G.S., Editor of *Life Lore*.

HOW wonderful everything is! the student of nature ever and anon exclaims with a feeling akin to worship. But if men spoke admiringly and awe-fully of the wonders of "creation" in pre-Darwinian times, when all was comparative chaos, with what feelings should they view nature now that the light of evolution streams down upon the universe? There is little doubt that many have been allured to the study of living things since the theory of evolution reduced chaos to order, and that the number of devout inquirers into the mysteries of nature has been enormously increased. Stolid scientists may deem it right to import no feeling into their studies, but the world at large will not avoid varying degrees of emotion—whether standing in front of the ocean, or observing the adaptation of a small organism to its environment. Our present task, however, is not to preach a sermon, but to attempt a description of one amongst a multitude of wonderful phenomena in living things.

If the skull of a young child were examined, it would be seen that upon its summit is a little place, about as large as a threepenny piece, where the bone has not formed, and where only a thin cartilaginous membrane covers what would otherwise be an opening into the skull. This is the place where the pulsation of blood vessels can be seen in the heads of young babies. It is one of the fontanelles—openings in the brain-case—which are not closed up by the

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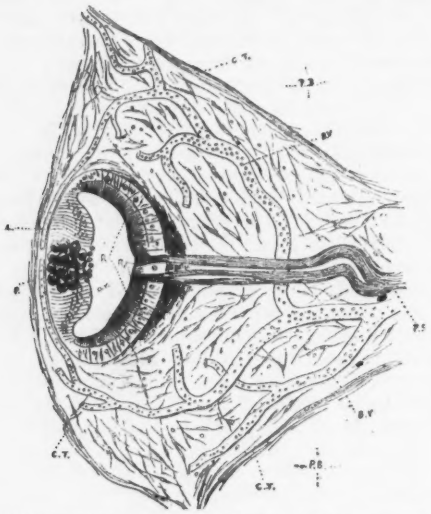
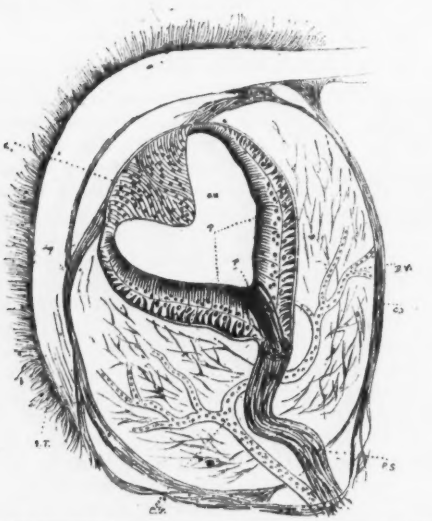
growth of bone until several months after birth. The term "fontanelle" was no doubt applied to these localities on account of a fancied resemblance of the pulsations there seen to a fountain (*fons*). The particular fontanelle to which attention is now drawn is called by anatomists the *parietal foramen*, because it is a hole through the walls of the skull.

Now that foramen has a very remarkable story to tell of the ancestry of the race of animals in whose skulls it is



SECTION (MAGNIFIED) THROUGH PINEAL EYE OF "VARANUS GIGANTEUS." O V, optic vesicle; P S, pineal stalk (optic nerve); L, lens; P, pigment; R, rods of retina; R', specialised rods at entrance of nerve fibres; C T, connective tissue; B V, blood vessels; P B, parietal bone.



SECTION (MAGNIFIED) THROUGH PINEAL EYE OF "HATTERIA PUNCTATA." References as in section of Pineal Eye of Varanus.

found. It marks, in fact, the position occupied in former generations by an eye. It is in the middle line of the skull, and hence reminds us of the Cyclops.

In some of the lower vertebrates the foramen remains unclosed throughout life, and in some a peculiar structure lies beneath it, of which the function has remained until very recently a complete mystery. It was spoken of by Descartes, if not by more ancient writers, as "the seat of the soul." On account of its shape—somewhat conical, and resembling the form of a pine-cone—it is called the "pineal body." In the human brain it is only seen after separation of the hemispheres, and it lies just in front of the *corpora quadrigemina*. It is larger in children than in adults, and in females than in males. In some amphibians and reptilians the structure is less simple. Lying between the wall of the skull and the connective tissue beneath, it is very liable to be overlooked.

That the pineal body is connected with an atrophied median eye will hardly be doubted after an examination of the structure and its connections in two genera of reptiles —*Varanus* and *Hatteria*—both very old types. The gigantic lizard, Varanus, may be looked at in the Zoological Gardens, Regent's Park. In the median line of the skull is one dermal scale of lighter colour than the surrounding ones. That scale marks the position of the obscured eye. Beneath there lies a perfect structure, a magnified section of which we show in an illustration. There is a crystalline lens, an optic vesicle, a beautiful retina (with its "rods and cones" turned in an opposite direction to that in which they occur in the paired vertebrate eyes—viz., in the same direction as they occur in the eyes of invertebrates), and an optic nerve connecting the structure with the brain. And may not the modified dermal scale represent an atrophied cornea? In Hatteria the eye is just as perfect, nay more so, since the pigment spots are absent from the crystalline lens.

In the little legless lizard known as the "slow-worm" or "blind-worm," the atrophied eye may be found, but no longer united by a nerve-strand with the brain. In the embryo frog it exists in complete connection with the brain; but in the adult the skull has severed the connection, and the eye lies *outside*. In man the eye has entirely disappeared, and what is probably the base of the nerve-strand, the "pineal body," alone remains.

In the long-extinct Labyrinthodonts, as well as in some of the Saurians, the parietal foramen presents ridges and grooves which probably indicate muscular attachments concerned in the movement of the eyeball.

Thus the old ancestral invertebrate eye must have survived long after certain offshoots of the invertebrate stock had taken up a distinctly vertebrate structure, and must have been used side by side with, or rather *between*, the paired vertebrate eyes. The ancient beasts, thus doubly provisioned, must have found the paired eyes more useful than the unpaired median eye. It would be impossible to say what different effects upon the brain and consciousness are produced by the turning back of the retinal rods and cones, since we have not the opportunity of comparison, being possessed of only one of the types of eye. But that ancestral forms suffered the one to become functionless by want of use proves the other to have been the better adapted to their requirements. No vertebrate now uses its ancestral invertebrate eye. Where the latter is possessed, it is hidden away beneath opaque tissues, a useless heirloom, but of intensest interest to those higher animals who feel a certain antiquarian affection for what is so pregnant with biological lore. Genealogies which carry us back only some twenty or thirty human generations have entrancing interest for many minds: how does the lesson of the pineal body and the parietal foramen in man compare with these, throwing back his ancestry through long geological ages?

The Queen has been pleased to confer the dignity of a Baronetcy on Professor G. G. Stokes.

CANDLES.

By W. Mattieu Williams.

IN the "good old times," as some folks call them, candles were made at home. In these good times those parts of England that were not barren sandy heaths were well supplied with swamps, in which rushes grew abundantly and without artificial cultivation. These rushes were gathered, soaked, and peeled by children and old women, as Gilbert White tells us. He also adds that "the careful wife of an industrious Hampshire labourer obtains all her fat for nothing, for she saves the skimmings of the bacon-pot for this use, and if the grease abounds with salt, she causes the salt to precipitate to the bottom by setting the scummings in a warm oven." He, however, omits to mention the water in which this melted fat was made to float, and which took away the precipitated salt by dissolving it.

The rushes used for candle-making have an axis of pith, which after peeling forms a very porous thin stick or rod, just stiff enough to be dipped in the bath of melted fat without yielding. The first dip fills the pores, and on cooling the rod becomes much stiffer. Then it is dipped again and again; at each dipping a fresh film of fat is picked up until the required thickness is obtained, and thus the primitive rushlight was made. Whether such candles are still extant I cannot tell, but I well remember them in common use as night-lights when I had the measles. They were sold in London for this purpose, as they required no snuffing.

The next stage was the substitution of cotton for the rush to form the wick. This was accompanied by the industry of collecting "kitchen stuff," and mixing it with slaughter-house refuse, which were melted down to form the home supply of tallow. With the growth of bad habits in respect to late hours, further supplies were demanded and obtained from other countries—such, for example, as the famous brand of P.Y.C. (Petersburg yellow candle) from Russia.

These innovations gradually superseded the domestic manufacture and introduced an intermediate stage, viz., the manufacture of candles by the retailers thereof. One of these establishments in the neighbourhood of Leicester Square happened to fall under my own observation when a schoolboy, and I will therefore describe the public exhibition which afforded much gratification and instruction to self and schoolfellows. The manufacture both of "dips" and "moulds" was conducted in the basement, or kitchen story of the tallow-chandler's shop, and all the mysteries were visible through a grating opening into the street.

The first stage of the dips was the preparation of the wicks to make them hang perpendicularly. This was done by simply dipping the end of each into the melted tallow, and thus forming a knob of tallow, which acted on the cotton like the bob of a plummet. Some dozens of wicks thus prepared were suspended in rows on an oblong frame. A vat just large enough to receive all these wicks was filled with melted tallow. Into this the suspended wicks were dipped three times, and thus received their first coating. This frame was then suspended in its place near the ceiling, and another similarly prepared brought down and dipped, then another, and so on, until the first was cool enough for a second coating. This was repeated until the requisite thickness was obtained. The sufficiency was tested by weighing the frame and its contents. Careful adjustment of the temperature of the melted tallow is necessary: if too hot it would melt away some of that already deposited around the wicks; if not hot enough it would deposit a coating with lumps or blobs. Winter was the busy dipping season.

The mould candles were made by pouring the melted tallow into a shallow trough, into the bottom of which were fitted a number of pewter tubes with conical terminations, and well polished inside. Down the axis of each of these tubes a wick was stretched, terminating in a knot that was drawn up to the small hole at the conical end, through which hole the wick had been threaded. The melted tallow, of course, flowed down these tubes, and thus the candle was cast or moulded.

The dips were for common use, the mould candles for drawing-rooms, for Sundays and evening parties. In those days ordinary people dined at dinner-time, and did not call it luncheon. Very superfine people used wax candles at 3*s.* 6*d.* per lb., or spermaceti candles at even higher prices, and dined at tea-time (5 P.M., and even later). Dining at supper-time was not yet invented, but the cost of winter banquets and evening parties was greatly exaggerated by the expense of lighting the *salons* of the luxurious, and candles were charged among the items of hotel bills—a practice that continued until recently on the Continent.

The snuffing of the tallow candles was a troublesome business; snuffers and snuffer-trays, now preserved in antiquarian museums, were ordinary and necessary articles of domestic furniture. The wax and spermaceti candles consumed their own wicks, but those of the tallow candles formed ugly carbonaceous lumps in the midst of the hollow flame, rendering it smoky and hideous, as well as dangerous, owing to the liability of the red-hot carbonaceous excrescence to fall.

One of the first applications of scientific principles to candle-making was the "patent metallic snuffless wick." The cotton of this was plaited, and through it ran fine wires of fusible metal. The plaiting was so devised that on liberation of its end by the melting of the tallow the wick split out into a sort of angular fork, each branch of which carried its own metal filament. As the ends of these melted, they weighed down their respective branches in such wise that they each leaned over nearly horizontally, and thus projected to the outside of the flame before reaching its middle height.

As the flame of a candle is but a hollow shell, the interior being filled with unburnt gas, and the inside even of the shell of flame itself being ill-supplied with oxygen, the cotton within cannot burn; but on coming through this shell of flame to the outer air it burns readily, being there highly heated and well supplied with oxygen. Thus the cotton of the two outspreading and somewhat pendent forks of the patent wick was reduced to impalpable ash, and its metallic portion to a fine powder of oxide, which fell away as practically invisible dust. Further improvements in the twisting or plaiting of the wicks causing them to droop over in untwisting rendered the metallic filament unnecessary.

The next and most important step was founded on the researches of Chevreul, to which I alluded when on the subject of soap in the January number of Knowledge. As may be remembered, tallow is composed of fatty acids united with glycerine. This being known, a natural question arises, Are they both of equal value as illuminating agents, or, if not, which is the best? By simply casting a little of each into a fire and observing the result, this question is answered: the fatty acid burns brilliantly, while the glycerine burns with difficulty, giving a dull lurid flame; it is, in fact, but barely combustible at all. Their respective compositions explain this difference.

The fatty acids, broadly speaking, are hydrocarbons, the glycerine a carbohydrate—*i.e.*, the first is composed of hydrogen and carbon, the second of water and carbon, or the elements of water and carbon. In the first, the hydrogen

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is ready and eager to burn by combining with oxygen; in the second, the thirst of the hydrogen for oxygen is already satisfied; it can take up no more, and is quite incombustible, as we know to be its condition in water.

Various methods of separating the glycerine have been devised. The first practically carried out was the lime process. About 10 cwt. of tallow or palm-oil was melted with about 140 gallons of water, and to these were gradually added about 100 gallons of milk of lime containing a quantity of lime equal to about 14 per cent. of the weight of the tallow. This mixture was heated and stirred until an insoluble soap was formed by the union of the fatty acids with the lime; the lime, being a stronger base than the glycerine, took the acid away and liberated it, the glycerine thus separated remaining dissolved in the yellowish liquor standing above the soap, from which it was finally separated and purified.

The lime-soap formed by the combination of the lime with the fatty acids is useless, but the fatty acids, having but feeble chemical energy, are easily displaced by a stronger mineral acid which combines with the lime and sets them free. If sulphuric acid is used, solid gypsum is formed, which settles down from the melted fatty acids, which are run off and washed to remove remaining traces of sulphuric acid and gypsum.

When cooled, these fatty acids solidify into a solid of crystalline structure commonly known as stearine, thus named from one of its constituents, the stearic acid. Stearine candles were made from this after pressing out the liquid oleic acid which was used for soap-making.

Other methods followed and superseded this, such as the use of superheated steam to diminish the quantity of lime required, the use of concentrated sulphuric acid, and, better still, the skilful application of the repulsive power of heat, which, at a temperature of about 570° (or a little higher when superheated steam is used as the heating medium), effects the direct dissociation of the fatty acids from the glycerine, and thus separates them in nearly pure condition.

Candles made of the stearine thus obtained are hard and free from greasiness. They burn with a much whiter, purer, and hotter flame than those made of tallow, one of the incidental advantages of this being the full combustion of the wick, as in wax and spermaceti candles (which are composed chiefly of the fatty acids), and therefore no snuffing is required.

Another and still more recent step in candle-making is that of using paraffin, which is a natural hydrocarbon obtained from the tarry oil that comes over when cannel coal and certain bituminous shales are slowly distilled, or, better still, from petroleum. This crude material is washed with sulphuric acid, which carbonises any carbohydrates that may be present by combining with their constituent water, the carbon thus separated sinking to the bottom as "acid tar," and is left behind when the mixture is redistilled.

A curious change is observable in the distillate thus obtained. It is not only refined as regards colour (crude petroleum is brown, and crude shale oil nearly black), but is seen to contain pearly crystalline scales when cold, scales that disappear when the temperature is raised. By lowering the temperature considerably these scales are easily separated by simply straining through suitable bags and pressing the contents of the bags until the liquid oil is so far run out as to leave a hard solid cake of the crystals behind. These, when further refined by washing in light mineral oil, constitute the beautiful substance that has received the name of "paraffin" on account of its lack of chemical affinity. It closely resembles spermaceti, and, mixed with a little wax, is nearly equal to it as a material for candles. Not long ago it was a chemical curiosity, now it is familiar to everybody in the form of the beautiful candles that are retailed at fivepence per pound, less than the former cost of the commonest tallow dips. These require no snuffing, but are inconvenient in hot climates on account of the low melting point of their material.

This defect was ominously displayed at a grand coronation ball given in Mexico by the ill-fated Maximilian. The *salon* was lighted brilliantly with some hundreds of these candles —then a novelty and imperfectly understood. As the dancing proceeded and the room grew warmer and warmer, the candles softened and bowed over, and streams of their melted material poured down so disastrously upon the dresses of the dancers that the ball was hastily terminated.

In all respects but this tendency to "gutter," owing to ready fusibility and the fluidity of the melted material, these cheap candles are equal to the costly wax and spermaceti of the luxurious. Science here, as in other directions, is foreshadowing the future course of human progress, whereby, without any reduction of rational and beneficial refinements and luxuries of the rich minority, the millions gradually and peacefully approach nearer and nearer to a general equality of partaking.

THE OCCURRENCE OF GOLD.

BY D. A. LOUIS, F.I.C., F.C.S.

IN considering the occurrence of gold, there are two or three of its properties which it is useful to bear in mind in order to account for the unique position it holds in the mineral kingdom; these are:—its high specific gravity, the great disinclination it exhibits to enter into combination with other elements, and the peculiarity of its solubility.

Most metals occur in nature mineralised or combined with various elements; for instance, silver is found sometimes free, but most frequently combined with sulphur as in silver glance, also with arsenic or antimony and sulphur in pyrargyrite and proustite, with chlorine in horn silver, and with other elements. Lead is universally found combined with sulphur and galena, also with carbonic acid as cerussite or lead spar, and in other combinations; tin, in its best known ore, cassiterite, is combined with oxygen, whilst zinc in blende is combined with sulphur, and in calamine with carbonic acid. But gold is one of the few elements which exist in nature free or uncombined, and with the exception of its existence in comparatively small quantities, combined with the rare element tellurium, it is always found in the metallic state. Native gold, however, contains varying proportions of impurities, the impurity in most instances being metallic silver, and perhaps copper; therefore we can dismiss the question of the chemical occurrence of gold with the statement that it generally occurs in the free state alloyed with more or less silver, and is sometimes found as telluride.

Turning to its mineralogical or petrological associations, a very similar degree of simplicity awaits us, for gold is, with few exceptions, found associated with the well-known non-metallic mineral quartz, whilst iron pyrites is the most general metalliferous mineral which accompanies gold, although copper pyrites, galena, blende, and arsenical pyrites are frequently auriferous, and some dozen other minerals are from time to time found to have particles of gold mixed with them. The rocks in which gold is found are mostly metamorphic, or those rocks which have in periods gone by been deposited during the decay of pre-existing rocks, but

have, some considerable time after deposition, undergone changes and, in many cases, have been subjected to great heat, to violent upheavals, disruptions, and compressions, with the result that they have become more or less crystalline, and frequently flaky or schistose in structure, and are traversed by numerous cracks and fissures in which quartz has accumulated, and, with it, gold in many instances. The rocks in which these auriferous quartz veins are generally found are those schists which are named from their predominating mineral chloritic, talcose, micaceous, or hornblendic; it is found less commonly in diorite, in porphyry, and sometimes in granite. These rocks often contain gold in very minute proportions, which becomes sometimes more prominent in the vicinity of a fissure or crack, but it is never present in quantities which would permit of the idea being entertained of its commercial extraction from this so-called "country" rock; in the intersecting quartz veins, however, gold is frequently found in paying quantities, and such veins constitute the "gold reefs" found in different parts of the world. Gold is never found in these veins in continuous bands, as is the case with other metalliferous deposits; but it occurs in patches and accumulations, here and there, in the vein; such patches are known as bunches, shoots, pipes, chimneys, according to the length, breadth, size, and position of the accumulation. In some cases veins are filled with pyrites instead of quartz, or sometimes, in fact very frequently, both are present, and the pyrites is found to contain gold; it then appears not to be so bunchy as when it exists in the quartz veins. I have seen in Colorado thick bands of auriferous pyrites, which, from their appearance in many adjacent mines, may be presumed to be many hundred yards in length, and apparently more or less continuous. Gold tellurides are also found in veins in Transylvania, in Hungary, and in Boulder County, Colorado.

Gold, however, does not exclusively occur in reefs; in fact, the largest supplies have been obtained from "placers," where it occurs in beds of sand or gravel, which have been, or are even now, the beds of rivers. Other instances are known where gold occurs in deposits consisting of fragments of rock cemented together by silicious material, forming what is known as breccias, or conglomerates, or puddingstone, or, in the Transvaal, as banket.

Both the auriferous sand and the banket owe their origin to the destruction—which is constantly going on now, and has been going on ever since the rocks have existed—of the auriferous rocks. The detritus, in the case of the sand, has been carried down the rocky slopes by streams of water, which have dissolved much of the rocky material, and carried away light particles, wearing away larger ones, and allowing the heavy gold and wear-resisting quartz to deposit themselves. In course of time the former has become concentrated in those parts of the river where the current has been interrupted by bends, &c., for the simple reason that the sand, being lighter, is to a large extent washed away by eddies of water which would not be sufficiently strong to move the heavier particles of the precious metal (the specific gravity of quartz is 2·65, while that of gold is about 19). Such accumulations are called "pockets." The "banket" deposits possibly originate in much the same manner, only the conditions being favourable, much of the detritus, which has become pulverised, and concentrated as regards gold, as in the case of the sand, has subsequently acted as a cement to the larger fragments, and so given rise to the present deposits.

There is still another form of deposit in which gold is found, and which is also derived from the destruction of older rocks. In this case the amount of water has been limited, and consequently the more refractory products of decomposition, instead of washing away to form banket or sand, remain on the spot or near it; moreover, they remain in great blocks permeated with vesicules and holes, which represent the positions previously occupied by the less refractory constituents, these having succumbed to the action of the various constituents of the atmosphere; that is to say, the moisture, the carbonic acid, and oxygen. The minerals left behind are principally quartz, some iron oxide, and gold, if present in the original rock; some of the gold will, however, dissolve. These spongy-looking deposits of ferruginous quartz are known as "gossan," and are generally found whenever the out-crop or the upper part of the lode is exposed to atmospheric action. If we take into consideration the enormous number of years during which these changes have been going on in nature, it is easy to realise that very extensive deposits of this description may have been brought into existence. They would, of course, be more localised than the banket deposits, which in their turn ought to be more localised than the alluvial or river deposits. The famous Mount Morgan mine in Queensland, Australia, is an instance of a deposit produced by atmospheric influences.

In alluvial deposits and in the various matrices the gold appears in many states of aggregation, which have received various names:—In nuggets, or pieces of irregular shape and of moderate size, in grains more or less crystalline, down to powder which consists of individual particles invisible to the naked eye; or it occurs as thin sheet gold, leaf gold, foliated gold, down to mere films of gold; and sometimes in long, thin aggregates of gold, such as that known as wire-gold, of moderate thickness, down to mere threads of gold.

Gold is found in all parts of the world. In Europe it is found in largest quantities in Transylvania, and in Hungary, where mines were worked by the Romans. It is also found in Spain, in North Italy on the northern slope of the Alps, from Monte Rosa and Simplon to Aosta, in Sweden, in Wales near Dolgelly, in Scotland near Leadhills, in Ireland in county Wicklow; whilst auriferous sands exist in the following amongst other rivers: Rhine, Rhone, Reuss, Aar, Danube, and many Cornish streams.

In Asia gold is found in the Ural Mountains, where it was probably mined by the Scythians; also in Siberia and in many other parts of Asia, notably India.

In Africa it occurs on the west coast, near Ashantee, known as the Gold Coast, and in the Transvaal, which is now so famous; it has been said that Matabele Land is one of the richest gold districts in the world. On the coast of Mozambique there are gold mines which are supposed to be the same which existed in Solomon's time under the name of mines of Ophir, which name has lately been applied to certain properties in that district, recently put on the London market. Gold also exists elsewhere in Africa.

In America, North, South, and Central, gold is very widely distributed. It is found in Mexico. In the United States, the gold mines of North Carolina, Virginia, Georgia, and South Carolina were once the great source of gold, but the discovery of gold in California in immense deposits soon eclipsed these and all other known gold deposits in the world; the subsequent discoveries in Australia, however, equalled them. Other States are gold producers—Colorado, Arizona, Idaho, Utah, some of the Eastern States, the newly created States Dakota and Montana, and the territories of Washington and Oregon. British Columbia and Vancouver's Island have gold—the former promises well for the future; so has Alaska; whilst gold is also found on the eastern side of Canada and in Nova Scotia. In Central America gold occurs in many places, including Honduras, Costa Rica, &c.

XUM

In South America, Brazil has long been famous for its gold mines; but gold is also found in the Argentine Republic, Venezuela, Colombia, and Guiana.

Australia is famous for its gold, and all who visited the Indian and Colonial Exhibition will remember the great arches built to represent the output from Victoria and New South Wales. It is also found in Quaensland, South Australia, New Zealand, &c.

THE SPECTRUM OF THE ORION NEBULA.

DR. HUGGINS has kindly sent us an early copy of an important paper he has communicated to the Royal Society on the spectrum of the above nebula, with a copy of a photograph showing some twenty-five very sharply-defined lines in its spectrum, and in the spectrum of the stars of the trapezium. At least four groups of bright lines in the spectrum of these stars can be traced into the nebula for some little distance from the stars. Dr. Huggins says :—

"It is scarcely necessary to state the importance of this observation as showing that these stars of the trapezium are not merely optically connected with the nebula, but are physically bound up with it, and are very probably condensed out of the gaseous matter of the nebula. . . . The first group of six lines occurs between λ 4116 and 4167. The lines of this group do not extend far from the continuous star spectra, with the exception of two lines. These can be seen faintly in another photograph taken in 1889. Beyond there is a fainter group, probably of four lines a little beyond *h*. I am pretty sure that these lines extend into the nebula. The third group from λ 3896 to 3825, of which I have endeavoured to measure ten lines, is faint; but there is no doubt that the same lines are present in the adjoining nebular matter. There are two lines a little more refrangible than the strong line seen in 1882, at about λ 3709 and λ 3699. I have a suspicion of a faint group about this place, and also of another group on the less refrangible side of G."

Dr. Huggins stated in 1872, as the result of numerous direct comparisons of the brightest of the nebula lines with the brightest line in the spectrum of nitrogen, that the nebula line was "sensibly coincident with the middle of the less refrangible line of the double line of nitrogen."

In a still more critical examination of the position of the nebula line for the purpose of determining whether there was any indication of relative motions of the gaseous nebulæ in the line of sight, he found some experimental difficulty from the circumstance that the nebula line is narrow and defined while N_1 is nebulous, but he was fortunate in finding a more suitable fiducial line of comparison in a narrow line of lead which falls almost upon the middle of N_1. In December, 1872, he compared this line directly with N_1, and found it sufficiently near in position to serve as a fiducial line of comparison.

Six other gaseous nebulæ were also examined, each on several nights, with the result that "in no instance was any change of relative position of the nebula line and the lead line detected."

In the simultaneous observation of the nebula line and the lead line it was found that if the lead line was made rather less bright than the line of the nebula, the small excess of apparent breadth of this latter line appeared to overlap the lead line to a very small amount on its less refrangible side, so that the more refrangible sides of the two lines appeared to be in a straight line across the spectrum. The closeness of position of the two lines was shown by the observation that when the line of the nebula passed across the field of the spectroscope, and the lead line was thrown in, nothing was seen but an increase in brightness of the nebula line. By comparing the end of the nebula line near the trapezium, where it is refined to a point, he estimated that the difference of position of the middle of the lead line and that of the nebula line might be possibly from λ 0000·2 to λ 0000·3. Some recent measures of the position of the lead line with the middle of N_1 show that the lead line is about λ 0000·12 more refrangible.

These direct comparisons of the nebula line with the lead line confirmed his former conclusion, that the brightest line in the gaseous nebulæ is very near N_1, when seen under a dispersion equal to nearly eight prisms of 60, namely, 36° 25′ from A to H.

Dr. Huggins's final determination of the wave-length of the brightest nebula line is λ 5004·6 to λ 5004·8.

In a paper read before the Royal Society in 1887, Mr. Lockyer says :—"Only seven lines in all have been recorded up to the present in the spectra of nebulæ, three of which coincide with lines in the spectrum of hydrogen and three correspond to lines in magnesium. The magnesium lines represented are the ultra-violet low-temperature lines at 373, the line at 470, and the remnant of the magnesium fluting at 500, the brightest part of the spectrum at the temperature of the Bunsen burner."

As Mr. Lockyer's theory, that the nebulæ are composed of sparse meteorites, the collisions of which bring about a rise of temperature sufficient to render luminous one of their chief constituents, magnesium, is based upon the above statement that the nebula lines correspond with the magnesium fluting. Dr. Huggins thought it desirable, on account of the "grave theoretical conclusions which Mr. Lockyer had based on his statement of their coincidence and on that of the photographic line about 3730 with the next strongest group of the burning magnesium spectrum, to undertake the laborious task of comparing, with the necessary care and precautions, the nebula line directly, in the spectroscope attached to the telescope, with the spectrum of burning magnesium.

Dr. Huggins says: "It will be seen by a reference to Mr. Lockyer's statement that he escaped from the difficulty of the known difference in position of the nebula line and that of the magnesium-flame band, by having taken the wave-lengths to three figures only."

Arrangements were made by which the light from burning magnesium was thrown into the telescope from the side and then reflected down, under conditions similar with the light from the nebula, upon the slit of the spectroscope. By this arrangement any flexure in the tube connecting the spectroscope with the telescope would affect both spectra alike. The direct comparison was successfully made on March 6. But Dr. Huggins failed to find the coincidence in position asserted, and the nebula lines are sharp, and show no winged character corresponding with the flutings of the magnesian spectrum.

The positions of the lines observed and photographed in the spectrum of the nebula are :—

Line measured by Dr. Copeland, probably D_3	λ 5874·0	
Brightest line	5004·6	to 5004·8
Second line	4957·0	
Third line, Hβ	4860·7	
Fourth line, Hγ	4340·1	
Line measured by Dr. Copeland	4476·0	
Strong line in photographs 1882 and 1888 about	3724·0	
Line in photographs 1888	3709·0	
" "	3699·0	
Photograph 1889. 1st pair	3752·0	
"	3741·0	

XUM

7. Ramified Lightning.—Taken at Meudon, near Paris, on June 24th, 1888, by E. L. Trouvelot.

8. Sinuous Lightning.—Taken on the Alleghany Mountains, U.S., on August 2nd, 1887, by L. S. Clarke.

CUNNINGHAM & LAWRENCE, COLLEGE HILL, E.C

Photograph 1889. 2nd pair.	about	λ 3285·0
	„	3275·0
„ „ Line at	„	3060·0
„ „ 3rd pair.	„	3053·0
	„	3047·0
Photograph 1888: Lines across star spectra, 1st group	„	4116·0
	„	4123·0
	„	4130·0
	„	4142·0
	„	4154·0
	„	4167·0
2nd group	approximate	3998·0
	„	3988·0
	„	3975·0
	„	3959·0
3rd group	„	3896·0
	„	3887·0
	„	3878·0
	„	3870·0
	„	3859·0
	„	3854·0
	„	3848·0
	„	3842·0
	„	3832·0
	„	3825·0

As to the chemical significance of the lines he has observed, Dr. Huggins says:

"Until I can obtain more photographs taken on different parts of the nebula, I wish to be understood to speak on this point with much hesitation, and provisionally only. We know certainly that two of the lines are produced by hydrogen. The fineness of these lines points to a high temperature and condition of great tenuity of the hydrogen from which the light was emitted. This condition of the hydrogen may give us a clue as to the probable interpretation of the other lines. These may come from substances of very low vapour-density, and under molecular conditions which are consistent with a high temperature. It is in accordance with this view that the recent measures of Dr. Copeland, since confirmed by Mr. Taylor, show with great probability that the line known as D_3, which has been supposed to indicate some substance of very low vapour-density, which shows itself only at the hottest region of the sun, is present in the nebula spectrum. The great simplicity of the three pairs of lines seen in the photograph of 1889 suggests a substance of a similar chemical nature.

"If hydrogen can exist at half its usual vapour-density, with a molecule of one atom only, we might possibly expect to find it in some of these bodies, but at present we do not know what its spectrum would be in such a condition. It may be possibly that it is in molecular states of our elements other than those we are acquainted with that we may have to look for an interpretation of some of the lines of these bodies."

PHOTOGRAPHS OF LIGHTNING.

By W. MARRIOTT and A. C. RANYARD.

EVERY one who reads this has probably experienced, at some time or other, strange feelings of awe during the passage of a great thunderstorm. Our want of knowledge with respect to the behaviour of lightning adds to the terror. As the thunder crashes and rolls we feel that we are in the presence of unknown forces. Some people even close all shutters and doors, and shut themselves up in fear and dread of observing the storm. Those, however, who have had the courage to watch a thunderstorm have found that they are not blinded by the lightning, though they have frequently learnt very little as to the form of the flashes or the direction in which they travel.

The duration of a lightning flash is inconceivably small, being in some instances about a millionth part of a second. This is proved by the observation of radial lines on a rapidly rotating disc, which appear absolutely stationary when illuminated by a lightning flash. The eye is dazed by the sudden brightness, and is unable to follow the flash, or to determine whether it proceeds from the clouds to the earth or from the earth to the clouds. The generally received idea has been that the lightning passes from the clouds to the earth; it is, however, probable that it most frequently proceeds from the earth to the clouds.

It is popularly supposed that lightning takes the zigzag course so frequently depicted by artists, but, as will be seen from the plates accompanying this article, lightning generally pursues a curious sinuous course. Mr. James Nasmyth, who was perhaps the first to give a correct picture of natural

FIG. 1.—ARTISTS' LIGHTNING AFTER NASMYTH.

FIG. 2.—NATURAL LIGHTNING, ACCORDING TO NASMYTH

FIG. 3.—BRANCHED LIGHTNING, ACCORDING TO NASMYTH.

lightning, believed the error of the artists originated in the form given to the thunderbolts in the hand of Jupiter as sculptured by the Greeks. In a paper communicated to the British Association in 1856, Mr. Nasmyth stated that he had never observed the zigzag form of lightning usually represented in works of art (as indicated in fig. 1), but that

the true natural form of a flash of lightning was more correctly represented by a crooked line as in fig. 2, and that it occasionally assumed the forked or branched form indicated in fig. 3. Any one who compares these woodcuts (which were those used in Mr. Nasmyth's article, and have been kindly lent by the British Association for the illustration of this paper) with the photographs of flashes of lightning shown on the plates will at once see what a keen observer Mr. Nasmyth must have been.

Two years ago the Council of the Royal Meteorological Society issued a circular stating that they desired to collect photographs of flashes of lightning, as they believed much valuable information might be obtained from them respecting some of the forms which lightning occasionally assumes. It had at times been reported at the meetings that ball lightning had been seen slowly moving through the air, occasionally entering rooms and bursting, and it was hoped that these photographs would throw some light upon the subject.

Nearly one hundred photographs from all parts of the world have been received in answer to this appeal, but no photographs of the ball lightning described have as yet come to hand. The photographs received were first shown at the annual exhibition of the R. Meteorological Society in March, 1888, and subsequently at the conversazione of the Royal Society, and on each occasion they attracted much attention.

In June last the Society published a report on these photographs, in which a classification was made of some of the various forms of lightning flashes. The six most typical forms are:—Stream, sinuous, ramified, meandering, beaded or chapletted, and ribbon lightning.

Some of the more remarkable photographs are reproduced on the accompanying plates by kind permission of the Council of the Society.

Plate I. contains six of the photographs taken in London during the terrific and prolonged thunderstorm which burst over the metropolis on the evening of August 17, 1887. This storm is described as being the most severe that has occurred in London for very many years past—the lightning was exceedingly vivid and brilliant, and the thunder loud and continuous. Certainly these six photographs show that the lightning assumed strange forms, and pursued very erratic and meandering paths. We shall refer to these photographs after describing those on Plates II. and III.

No. 7 on Plate II. is an example of ramified lightning, the flash dividing and branching off in various directions. The flash at the right hand of the photograph appears to have twisted and turned about in a curious manner. This photograph was taken by Mons. E. L. Trouvelot, at Meudon, near Paris, on June 24, 1888. No. 11 is another example of ramified lightning, in which little flashes branch out from the main flash, though we have no evidence as to whether these fibres branch off from, or run into, the main flash. It will be noticed that in most instances the lower or earth end of the flash is brightest.

No. 8 shows a grand display of sinuous flashes, the lightning also illuminating the thunder-clouds. This photograph was taken by Mr. L. S. Clarke from the top of the Alleghany Mountains on August 2, 1887. No. 11 is also an example of sinuous lightning. In this photograph several flashes appear to follow almost the same path, though, as the plate was exposed for some time, we have no means of knowing whether these flashes occurred almost simultaneously or whether there was a considerable interval between each. Neither have we any knowledge as to the distance of the lightning from the camera. Mr. H. C. Russell, of the Sydney Observatory, has just sent over a photograph which shows three or four flashes of lightning much closer together than those in No. 11. He was able to determine the position of the thunderstorm, and found that the lightning was about twenty-six miles distant. The flashes may consequently have been some distance apart.

No. 9 is an example of the meandering and beaded forms of lightning. The main flash seems to wander about in an aimless sort of way, while in the central flash in the upper part of the photograph there appear to be two bright spots. It has been suggested that these bright spots are caused by the flash at those points moving directly towards, or away from, the camera, and consequently giving a somewhat longer exposure at these spots.

Nos. 12 and 13 are examples of the ribbon form of lightning, in which the flash has the appearance of a piece of ribbon being waved in the air, the front edge being brighter than the other part. Nos. 1 and 2 on Plate I. have also the same appearance but in a more marked degree.

Several suggestions have been made as to the probable cause of this ribbon-like appearance. One suggestion is that the second fainter image is formed by internal reflection from the back of the glass plate. This duplication, however, is not confined to glass negatives, but occurs on paper negatives as well. No. 13 was taken on a sensitive paper film. Another suggestion is that the double image is formed by the internal reflections of doublet lenses. A third suggestion is that the lines are caused by the shaking of the camera in the direction of the folds of the ribbon. None of these suggestions seem, however, to be borne out by a close examination of the photographs. If the streaks were due to reflections from the surfaces of the photographic lenses, we should expect to find a symmetrical arrangement of such ghosts with respect to the axis of the lenses or the centre of the plate; but there is clearly nothing of the kind. It will be noticed that the delicate lace-like filaments in photograph No. 1 are not quite parallel on different parts of the plate, but the want of parallelism of the filaments seems to be rather due to perspective than to a shift of the plate; this is even more noticeable on photographs 12 and 13. If the camera could be shifted rapidly enough during the minute fraction of a second which the lightning flash lasts to cause such traces on the plate, all the tracks would be parallel to one another or tangential about a centre round which the camera had moved; but there is clearly no such arrangement, and the brighter streaks do not correspond with brighter spots on the edge of the ribbon, as would be the case if they were due to a shift of the plate. Recent experiments by Mr. J. Wimshurst with his electrical influence machine have conclusively shown that in the case of such sparks as can be produced in the laboratory, a rapid motion of the plate will not give rise to streaks. Mr. Wimshurst has made a dark slide for his camera, to which is fitted a train of clockwork carrying a disc, upon which is an arrangement for holding the sensitive plate. When all is complete for photographing a flash, the clockwork is wound up, the sensitive plate then rapidly acquires great velocity, which at the maximum reaches 2,500 revolutions per minute, and the plate rotating at this speed, the spark is photographed. The photographs thus obtained in no way indicate movement in the sensitive plate, the flashes being quite sharp and distinct.

It will be noticed that the brighter streaks proceed from parts of the ribbon edge where there is a sudden change in direction of the stream—possibly the appearance of increased brightness may be merely an optical illusion caused by greater thickness of the stream at these points as seen in projection. On this supposition the flash would consist of a bright sinuous band, with a broader and fainter band running parallel with it. The flash in photograph No. 6, when examined with a lens, is seen to be of the same ribbon-like character, the plane of the ribbon remaining

apparently parallel to a fixed line in space through the whole of the loop and the convolutions of the knot or contorted region where the two flashes join and branch off.

A similar appearance of parallelism of the striæ to a fixed line may be recognised in the other photographs of ribbon flashes; possibly the striæ always make the same angle with the horizon, for there is some doubt as to whether photographs Nos. 1 and 2 are the right way up upon the page. Photographs of such contorted ribbon flashes from two points would enable us to determine whether there is any connection between the direction of the striæ or folds and the earth's magnetic axis, or whether the direction is determined by the prevailing wind or other meteorological conditions. Similar folds are shown in many drawings of the Aurora. Some good woodcuts of Auroral curtains have recently appeared in the German periodical, "Himmel und Erde," according to which the Auroral striæ are nearly perpendicular to the horizon. But the drawings were made in the neighbourhood of the earth's magnetic pole.

If No. 4 be examined carefully it will be seen that in addition to several ordinary white flashes, there is a *dark* flash of precisely the same character as the bright flashes. A suggestion has been made that this may be the result of a very bright flash so over-exposing the plate as to produce the well-known reversal effect by over-exposure, as when the disc of the sun appears black on a positive print instead of white. Professor Stokes, who has examined the photograph, says: "The dark flash was perhaps produced by a previous flash before the cap over the lens was taken off, which had produced nitrous oxide along its track. The actual flash photographed would then illuminate the background of cloud, but this light could not pass through the nitrous oxide, and thus would give a dark track due to absorption." If the dark flash were due to over-exposure, its edges and fainter parts would be bright, but there is no such evidence of photographic reversal having taken place. In the case of the curtain form of flash, No. 2, with a dark line running along it parallel to the bright edge, this may possibly be due to a previous curtain flash in front which produced the nitrous oxide gas which cut out the light of the second flash.

It is to be hoped that some one will be able to make experiments to test this theory. Professor Stokes has suggested that during a thunderstorm in the daytime a camera should be charged and the cap taken off the lens just after a flash has been seen; then, according to his theory, a dead flash should show itself on the plate.

More than one photograph of such a flash would be of great interest in showing how the dead flash disappears. The tracks left by meteors in the upper air occasionally remain visible for half an hour or more, and are seen to be bent and drifted by the wind. The behaviour of the dark track might, perhaps, give some clue as to whether it is due to the smoke of burnt dust particles floating in the air, or whether it behaves as a column of gas might be expected to behave while being lost by diffusion into the surrounding air. If the dark column is due to smoke a photograph taken with a large double image prism, placed in front of the camera lens, would, if the column of smoke were illuminated by a side light, probably show a difference in brightness of the two images, due to polarisation of the light dispersed by the smoke particles, and we should expect to find such a column darker in the lower air and in cities where inflammable dust exists than in the case of lightning photographed from a mountain side; but, during the thunderstorm season, the air in the open country is frequently charged with pollen to a considerable altitude. It might be well to test the character of the dust by burning the sediment from rain collected during the storm.

Nos. 3, 5, and 6 are further examples of the meandering form of lightning. No. 6, which was taken at Clapham by Mr. J. Guardia, is not only a very good specimen of the ribbon-type, but is a remarkable example of the strange course sometimes taken by lightning. The flash seems to have twisted and turned about in a very curious manner, and to have apparently taken an oval course, and come back upon itself. It would have been very interesting if we could have had another photograph of this same flash taken from a different point of view. We could then have fixed the position of the flash, and ascertained its length. The length of a lightning flash may be some miles in extent. Mr. L. P. Muirhead states that during the thunderstorm which occurred at Glasgow on May 19, 1888, he observed a very long and bright flash which by the Ordnance map he judged to have been six miles long.

There is a form of lightning of which at present no photographs have been obtained, viz., ball or globular lightning. This appears as a ball or globe of fire, varying in apparent size from a cricket ball to a football; it moves very slowly —in fact, some people have stated that they have been able to get out of its way—and, as a rule, finally explodes with great violence. Arago, in his "Meteorological Essays," gives several accounts of this phenomenon. Thus at Milan in 1841, one of these globes moved along a street so slowly that the spectators walked after it to watch it, and the narrator, who first observed it from a window, ran downstairs, and saw it for three minutes before it struck the cross on a church steeple and disappeared. Such statements are very frequent, and there is no reason why they should be doubted. Dr. Tripe, of Hackney, says that on July 11, 1874, while watching a thunderstorm, he saw a large ball of fire rise apparently about a mile distant from behind some low houses. It first rose slowly then accelerated its pace as it ascended, and gradually acquired a very rapid motion. When it had risen about 45°, it started off at an acute angle towards the west, with such rapidity as to produce the appearance of a flash of forked lightning.

A very remarkable account of globular lightning in the Glendowan Mountains, in county Donegal, was reported by Mr. M. Fitzgerald some years ago to the Royal Meteorological Society. He says:—"From its first appearance till it buried itself could not have been more than twenty minutes, during which time it travelled leisurely, as if floating with an undulatory motion through the air, over one mile. It appeared at first to be a bright red globular ball of fire, about two feet in diameter, but its bulk became rapidly less, particularly after each dip in the soil, so that it appeared not more than three inches in diameter when it finally vanished."

From what has been already said, it will be seen that the photographs have brought out several facts about lightning which had hitherto been entirely unsuspected. Additional photographs would probably still further increase our knowledge, and also confirm or disprove some of the conclusions already arrived at. As the thunderstorm season is now approaching, it is to be hoped that many photographers will take up this interesting subject and secure a goodly number of photographs of flashes of lightning. As the plate can only be exposed at night, the lens should be focussed for some distant object during the daytime, and a mark made on the camera, so that it can be easily adjusted at night.

A rapid rectilinear lens with full aperture should be used, and if possible some building or landmark should be included on the plate to give the position of the horizon. The exact position and aspect of the camera should always be carefully recorded, as well as the precise time of any flash that may come within the field of view. These particulars are very

XUM

necessary, as if the same flash were photographed from two or more points, we should be able to fix the position of the flash in the air, and determine its size. The time interval between the lightning flash and the thunder should always be noted, as this will afford the means of ascertaining how far off the lightning is. For all practical purposes we may allow 5 seconds to a mile. It is desirable, if possible, not to have more than one flash upon a plate. Particulars should also be recorded of the direction of the storm, the movement of clouds, the direction and force of the wind, &c.

More is likely to be learnt with respect to the structure of these ribbon and dark flashes if they can be photographed on a large scale. There is a limit to the size of the camera which can be conveniently used, but it is evident that the nearer the flash the larger will be the angle that it subtends upon the plate. For this reason it is not photographs of flashes upon the horizon that are so much needed as photographs taken in the midst of a storm. With a storm immediately overhead, the points of reference necessary for determining the parallax and height of the flash by comparison with another photograph might be obtained by noting the place of the camera and including chimneys in the picture, or telegraph-wires or strings stretching across the sky.

The subject of lightning flashes is only part of the investigation which the R. Meteorological Society has on hand in connection with thunderstorms. The Society is collecting observations on British hail and thunderstorms with the view of gaining some knowledge of the nature and causes of the different kinds of thunderstorms, and discovering the localities where hail and thunder are most frequent and destructive. Much valuable information has been already received which is now being collated and discussed. Mr. Marriott would be glad if the readers of KNOWLEDGE would favour him with observations made during thunderstorms; even simple records of the times when thunder, lightning, rain and hail begin and end, and when they are loudest, brightest, or heaviest, would be acceptable. Notices of distant or sheet lightning, with the time of its occurrence and the direction in which it is seen, are also of service in tracing the path of a thunderstorm. This was well illustrated in the case of the storm which occurred on the night of May 18, 1888. This thunderstorm came up from the English Channel about 8 P.M., passed across the country in a north by west direction, and reached the Firth of Forth by 4 A.M. on the 19th. The distance traversed was over 400 miles, the rate of progression being 50 miles an hour. Many observers in various parts of the country only saw lightning; but where they gave the time and direction in which the lightning was seen, it was found that these agreed precisely with the positions of the thunderstorm at those times, although the observers, in two cases at least, were more than 100 miles from the storm.

The Meteorological Society is anxious to secure as large a collection as possible of lightning photographs. Readers of this paper who wish to assist in the research should forward the original negatives if possible, or, if not, prints from them, to Mr. W. Marriott, secretary of the R. Meteorological Society, 30 Great George Street, Westminster, S.W. Any other information bearing on the subject of thunderstorms will also be welcomed by him. It would be well to mark the top of the sensitive plates before they are put into the dark slide for exposure, so that there may be no doubt as to the orientation of the picture if no buildings or trees are included. But pictures with reference marks, from which the parallax and the actual size and position of the flash can be determined, cannot be too much insisted upon. The time of the flash, and the interval between it and the thunder, should, in every instance, be noted, and the observer's watch should be compared as soon after the storm as possible with post-office time.

TOTAL SOLAR ECLIPSE OF 1889.

JANUARY 1.

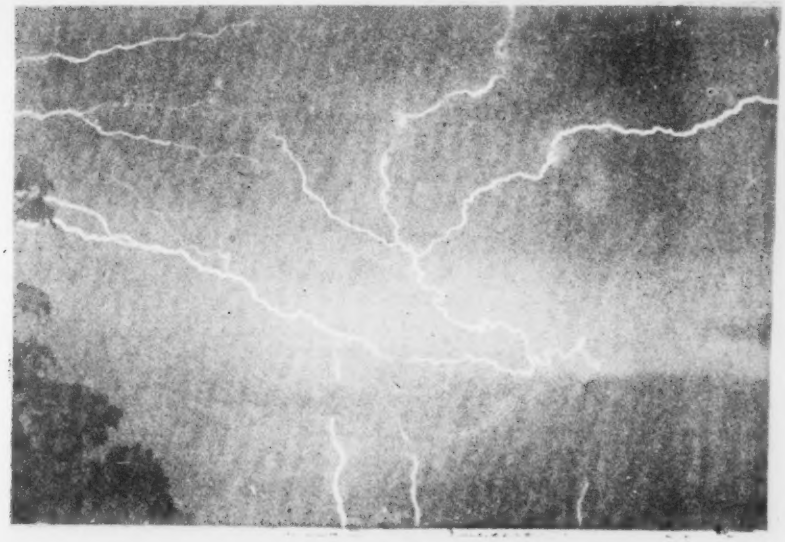
BY A. C. RANYARD.

PHOTOGRAPH No. 14 on Plate III. is copied from a transparency on a flexible film, which has been kindly sent me by Professor W. H. Pickering. The transparency was made direct from the original negative, and shows a great deal more coronal structure than is reproduced in our illustration. The difference of brightness between the coronal details and the background on which they are seen is so slight that there is always difficulty in reproducing them, and copies of coronal photographs are always much inferior to originals in showing such details.

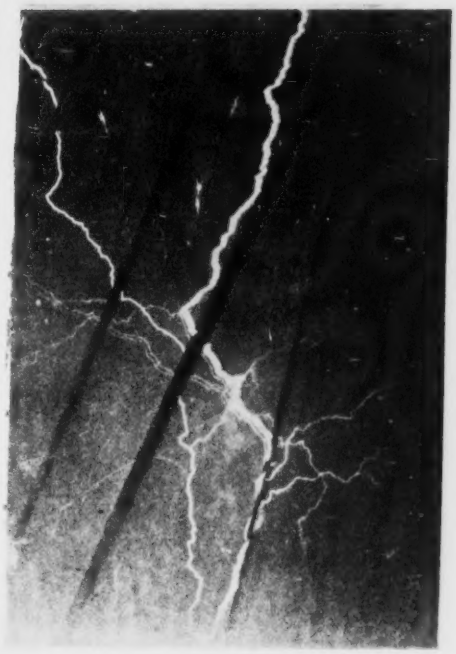
The original negative was taken at Willow, California, with a lens of thirteen inches aperture, and an exposure of ten seconds on a Carbutt A plate. It is the largest photograph of the corona which has yet been taken in the primary focus of an instrument, though in the early days of eclipse photography more than one photograph on a still larger scale was taken in the secondary focus of instruments, but the extent of corona shown in such early photographs was very small as compared with that shown in Professor Pickering's photograph. The sun's axis is as nearly as possible vertical on the page, the north pole being uppermost. It will be noticed that this corona is not quite symmetrical with respect to the sun's axis, the chief equatorial extension being a little northward of the solar equator on the west side, and towards the south on the east or left-hand side of the picture. There has been a similar want of exact symmetry with respect to the sun's axis in other coronas. The position of the sun's axis is derived from the observation of the motion of sun-spots in the equatorial regions; but the corona, both in its equatorial regions and polar rifts, has in several instances shown a tendency to symmetry with respect to a line which does not correspond by some 10° or 15° with the axis of rotation as derived from the observation of sun spots.

In the transparency sent by Professor Pickering, four synclinal groups of structure are distinctly shown, symmetrically placed with respect to the general axis of symmetry of the corona. The northern edges of the two northern synclinal groups and the southern edges of the two southern synclinal groups show marked contrary flexure. The rays bounding the polar rifts are greatly inclined to the radial at the point where they spring from the sun's limb, as in the case of the 1871 corona, and are concave towards the axis of the synclinal groups in their lower regions and convex above; a similar contrary flexure is noticeable in the rays bounding the polar rifts of the 1871 corona. The corona of January 1889 corresponds to a period of solar quiescence, as measured by sun-spot disturbances. It is similar in many respects to other coronas, which have been observed at other periods of sun-spot minima. There is great equatorial extension of the corona, and there are broad polar rifts. On the transparency sent over by Professor Pickering, though a great many curved rays are visible, no great tree-formed structures, with spreading heads and narrow stems, can be recognised. Such structures seem to be associated with periods of greater sun-spot development.

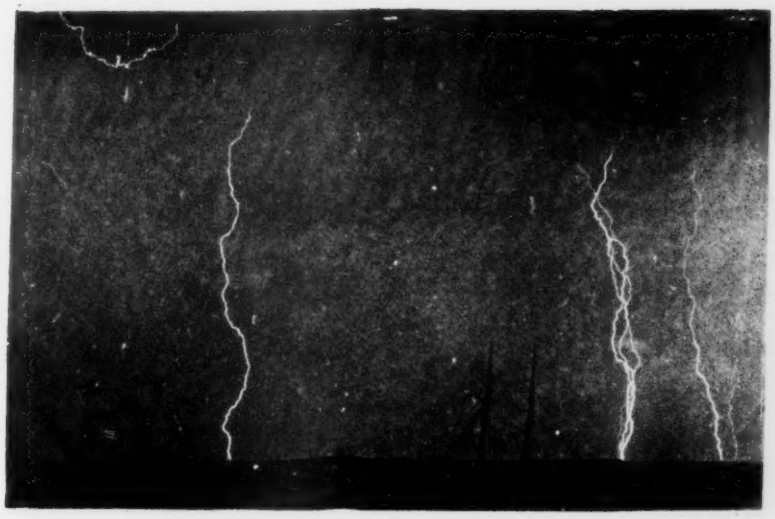
9. Meandering and Beaded Lightning.—Taken at Rougemont, near Tours, on May 26th, 1886, by H. Schleusner and E. B. Vignoles.



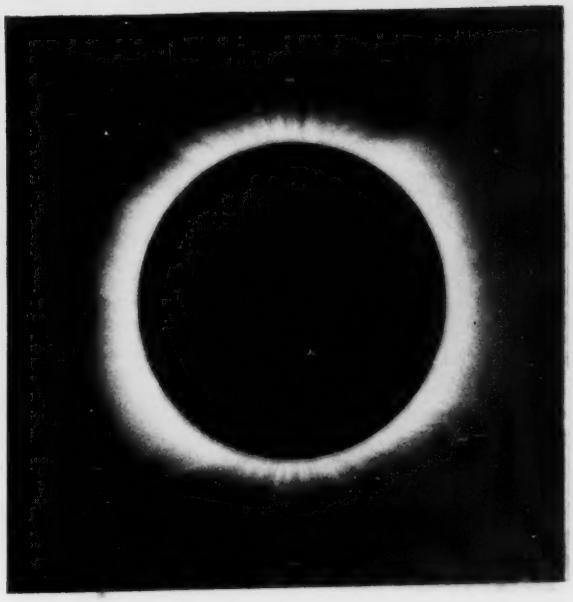
12. Ribbon Lightning.—Taken on Board H.M.S. "Neptune," between Madeira and Gibraltar, on November 14th, 1884, by Dr. Puddicombe.



10. Sinuous and Multiple Flash Lightning.—Taken at Greenwich, Connecticut, in July, 1886, by Dr. Pippard.



13. Flash of Ribbon Lightning, at Bournemouth, October 6th, 1886, by Dr. Drewitt.



11. Ramified Lightning.—Taken at Philadelphia, on July 22nd, 1887, by W. N. Jennings.

14. Corona of 1st January, 1889, from photograph taken by Prof. W. H. Pickering, at Willow, California.

CUNNINGHAM & LAWRENCE, COLLEGE HILL, E.C.

LIGHTNING PHOTOGRAPHS.

XUM

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

ON THE SYSTEM OF SHORTHAND EMPLOYED BY ABRAHAM SHARP.

To the Editor of KNOWLEDGE.

SIR,—In your interesting notice of Mr. Cudworth's "Life and Correspondence of Abraham Sharp" in the March number of KNOWLEDGE you have given a facsimile of the end of a letter from Flamsteed, and of the draft of Sharp's answer to it which is written in shorthand.

Mr. Cudworth mentions that in Sharp's note-books there are many of such shorthand notes, but that he had quite failed in his attempts to decipher them, and he states that Mr. Baily, before him, had been equally unsuccessful. A correspondent of yours in the same number of KNOWLEDGE mentions that from the study of a specimen of Sharp's shorthand writing on a letter dated June 1705, he had succeeded in mastering the alphabet and most of the symbols, but he seems not to be aware that the system employed is one by a known author. Although I have no pretension to be an expert in shorthand, I happen to be in a position to clear up this matter, and I think that it may perhaps be interesting to some of your readers if I explain briefly the circumstances that led me to acquire the information which I am now able to give. Several years ago, when examining the Newton MSS. belonging to the Earl of Portsmouth, a portion of which he has presented to the University of Cambridge, I found a small note-book of Newton's containing, among other things, two or three pages of memoranda written in shorthand and numbered in consecutive order, all of them belonging to the year 1662, which was written in plain figures. This was the year immediately following that in which Newton came into residence in Trinity College.

Naturally I was curious to decipher these memoranda of Newton's, and I had great hopes that by consulting the extensive collection of ancient books on shorthand, made by Pepys, and preserved in the Pepysian Library, I might be enabled to do so. The librarian of Magdalene College most kindly allowed me to examine these books and I found, as I expected, that one of them contained an explanation of the identical system of shorthand which had been employed by Newton. After a little study I was able to read every word which occurred in these memoranda, which, however, were all of a private, personal character, having no reference to science.

The author of this system of shorthand was Thomas Shelton, and the title which he gave to it was Zeiglographia. I have a copy of this book dated in 1659, but I believe that the work went through many editions. The same author published an earlier work on the same subject, with the title Tachygraphy, my copy of which has the date 1645. The systems explained in these works are quite similar in principle, but the alphabets are entirely different. On referring to Abraham Sharp's shorthand letter given in KNOWLEDGE, I saw that the alphabet was the same as that of Zeiglographia, and I readily made out that the letter referred to the fright caused by the rebels in 1715 passing in the neighbourhood of Bradford, where Sharp was then residing, and that it was in fact the draft of the letter which appears under the date October 19, 1715.—Yours faithfully,

J. C. ADAMS.

Observatory, Cambridge.

To the Editor of KNOWLEDGE.

DEAR SIR,—I am obliged for the opportunity afforded me of reading Professor Adams's interesting letter on the shorthand used by Abraham Sharp. My letter in KNOWLEDGE, March 1, in which I stated I had partially deciphered three of Sharp's letters to Yarwell from the shorthand copy is referred to, under the impression that I was unaware of the system used. This was not the case however. I intended to imply that I knew it by stating that it was "a system of which very little was known," and I told you in conversation that I was acquainted with the system. It is really Coles's, not Shelton's, but the two are so alike that one needs to be intimately familiar with them to detect the difference. I know something of over two hundred systems, but generally attack an old shorthand problem as I would a cryptogram, without thinking of systems. I saw at once that it was on the lines of Thomas Shelton's Zeiglography (1650), and that it was from Elisha Coles's adaptation of the same (1674). This was corroborated on consulting the only accessible edition—the tenth (1710), unfortunately a mutilated one. With this defective material to help me, I was able to send you on March 1 a complete transcription of the letters to Yarwell, and on March 7 a transcription of the shorthand facsimile of Sharp's letter to Flamsteed (*vide* KNOWLEDGE, April 1). A German friend to whom I had presented a copy of the New Testament, neatly written in Coles's shorthand, kindly returned it to me a few days after, but too late to serve me with the above transcription.

On reference to my "Bibliography of Shorthand" (1887), there will be found among its 5,000 items of shorthand books, pamphlets, MSS., &c., in English and Latin, thirty-seven entries under "Thomas Shelton," but only three entries to "Elisha Coles."

Most of the old shorthand systems are similar in their alphabets, and the signs are easily recognised, but the mere knowledge of an alphabet will not go far in the decipherment of letters of the seventeenth and eighteenth centuries. There are complex arrangements for unwritten but indicated vowels, tables of complete and broken consonants, lists of prefixes and terminations, grammalogues, arbitraries and symbols, which block the decipherer's course. Coles made many additions to Shelton's Zeiglography, notably a neatly engraved table of 500 "symbolicalls," and a table of "our most usuall words," 240 in number—a great improvement on Shelton's limited system.

The greatest difficulty in deciphering old shorthand notes arises from the duplex forms of signs for consonants and vowels, words and phrases of the most opposite meaning having similar and even identical outlines. For instance, in my transcript of the letter to Flamsteed I took a sign, *aw*, or *alw*, for "allow," and now find it should be *ac*, for "acknowledge," which also stands in Coles's system for "account" and "according."

To-day, for the first time, I have the use of a copy of Mr. Cudworth's "Life of Abraham Sharp," and have examined the letter of October 19 referred to by Professor Adams, which appears to be a copy of the original long-hand letter to Flamsteed, of which, in KNOWLEDGE, March 1, you had a facsimile of Sharp's shorthand notes. I gave the date—January 19, 1715–16; and this must be correct, as the letter was evidently written a few weeks after the taking of Preston by the Royal troops on November 13, 1715. It was in the well-known Derwentwater rebellion. There are several differences between the long-hand copy and the shorthand transcription. Beyond those variations of mine, due chiefly to the duplex outlines already mentioned, there are other mistakes and omissions in the long-hand copy which I cannot account for, except on the assumption of

misreadings by the long-hand transcriber, or actual variations.

The two shorthand systems of Shelton, Tachygraphy (1641) and Zeiglography (1650), although very different from each other, seem to have been held in great repute among the scholars and divines of the seventeenth century, even long after Rich's system (properly Cartwright's) had become popular. Shelton's Tachygraphy was used by Pepys in his well-known diary and correspondence, although when the Rev. J. Smith deciphered the original shorthand MSS. for Lord Braybrooke, he was under the impression that it was Rich's system. Archbishop Sharp (1642–1673), a supposed cousin of Abraham Sharp, wrote shorthand from his earliest to his latest years. His father, the drysalter, had it taught to him at a Bradford school. The system was probably Shelton's Zeiglography. All his works were written in shorthand, and the diary of his life from 1702 to 1713 was transcribed by his son, the Archdeacon, "Tom Sharp," the notice of whose study of an uncouth system of shorthand along with his friend Byrom is so well known. Archbishop Sharp had the reputation of preaching by heart, or making slight use of notes, when the fact was his sermon—written in shorthand—was before him, so disposed that he could look off and on, and with transient glances catch the sentences as required, giving meanwhile life and zeal to his utterances.

It is not generally known what a number of famous men of old times used the art of shorthand as an assistance to study or for official purposes. I may mention a few names without placing them in strict chronological order:—Roger Williams, the Puritan, founder of the State of Rhode Island, who wrote shorthand for Sir Edward Coke; Bishop Wilkins; Sir Henry Nicholas, secretary of Charles I. and II.; Bishop Jewel, who wrote in his own Tachygraphy at the trial of Ridley and Latimer; Elias Ashmole; Archbishop Secker; Sir Isaac Newton, who used Shelton's system; Dr. Hartlib; Dalgarno; Dr. Wallis; Dr. Holder; Defoe, who reported the speeches of Fletcher of Saltoun, Seton, and other Scottish patriots in the Scottish Parliament of 1669; Pepys; John Evelyn; Dr. Hartley; Franklin; Dr. Kippis; Dr. Darwin; Dr. Aikin; Dr. Fordyce; Doddridge; Sir Henry Cavendish; John Sturt, the engraver; Clement Walker, of Lilburn's time; Le Sieur Ramsay; Strype; Van Hove; Dr. Crutziger, who reported the disputations of Luther, Eck, and Melanchthon; Noah Bridges; Boerhave; Violi, who noted Savonarola's orations; Charles I. in correspondence with the Marquis of Worcester; Morrice, General Monk's secretary; Sir Henry Wotton; Cardinal Wolsey; Burnet; Rushworth, of the "Historical Collections"; Dr. Chamberlain, of "Anodyne necklace reputation"; Pierre Carpentier; John Locke; Holyoke, the early Harvard President; Lodwick; Archbishop Laud; Judge Sewall, the Puritan; Archbishop Usher; Lord Dartmouth; Lord Chancellor King; Horne Tooke; John and Charles Wesley; Dr. Watts; Dr. Blair; Enfield; Dr. Barbauld; Philip Gibbs; Priestley; Professors Gilbert and James Robertson; Job Orton; Hugh Farmer; Philip Holland; Dr. Caleb Ashworth; Dr. Samuel Clarke; Richard Baxter; Breithaupt; Wachter; Boswell; Jennings; Stackhouse; Dr. Mavor; and Gibbon. I wonder how many shorthand MSS. of one or other of these celebrities would be discovered if public libraries and private collections were thoroughly ransacked.

With respect to the shorthand notes of Sir Isaac Newton, which Professor Adams has deciphered, I have no doubt that he would find, if he published them, that a wide interest was taken in even small and personal details of the life of such a man.—Yours faithfully,

May 23, 1889. JOHN WESTBY-GIBSON.

INSECT SWARMS IN SOUTH AMERICA.

To the Editor of KNOWLEDGE.

Rio de Janeiro: April 20, 1889.

DEAR SIR,—I beg to enclose a translation of a newspaper extract, which may be of interest to some of your readers.—Yours truly, G. W. NICOLLS.

"On March 25, at Buenos Ayres, an enormous quantity of moths was noticed flying about in the evening. At night there fell upon the city, like fine rain, such an unprecedented invasion of small flies that in some places the passers-by were obliged to run. In the theatres, cafés, houses, and streets it was impossible to go a step save through legions of these insects. Some one, out of curiosity, having counted 20,000 in a square vara (about 44 inches), calculated that there could not have fallen less than 500 thousand millions over the whole city. Such a phenomenon is quite unheard of in the locality."

DOUBLE STARS.

To the Editor of KNOWLEDGE.

SIR,—I ask permission to make a remark or two in reply to your editorial comments on my paper on the above subject. As to the blue stars referred to, I am not familiar with them, but Sir John Herschel, who spent some time at the Cape, must have known them, and could not have regarded them as possessing the decided blue tint exhibited by the fainter of many pairs of stars. The colours of stars, however, is a subject on which different observers frequently differ, and I believe that the supposed changes in the colours of certain stars chiefly arise from this cause. With regard to the majority of stars with sensible parallax being double, however, I cannot assent to your criticism. The thirty-four stars in Young's "General Astronomy" cannot be regarded as stars with a sensible parallax. In two of them the only parallaxes given are negative, and both of these are single stars, viz. Betelgeuse and α Cygni. Two other fine single stars, Arcturus and Vega, have, according to the latest determination (Elkin's), insensible parallaxes (0·018″ and 0·034″, both figures being less than the probable error). In several other cases the parallaxes are almost equally small, and, where they are more considerable, they usually depend on the observations of a single astronomer sometimes made before the difficulties and uncertainties of such measurements were fully known. If we mean by near stars, those for which a parallax exceeding 0·1″ has been found by two independent observers, and for which no parallax of less than 0·1″ has been found by any observer, I think the following list is nearly complete—α Centauri, 61 Cygni, Sirius, Procyon, Aldebaran, Altair, and o_2 Eridani. There may be others which I have overlooked. All of these are either certainly or probably double stars with the exception of Altair. The agreement in proper motion and parallax of the two components of 61 Cygni seems to me almost conclusive as to their physical connection.—I remain, truly yours, W. H. S. MONCK.

Dublin: May 4, 1889.

P.S.—As to the evidences of physical connection afforded by the colours of double stars, I may cite Professor Young ("General Astronomy," p. 494):—"Not unfrequently the components of a double star present a fine contrast of colour, *never, however, in cases where they are nearly equal in magnitude*. It is a remarkable fact, as yet wholly unexplained, that when we have such a contrast of colour the tint of the smaller star always lies higher in the spectrum than that of the larger one. The larger one is *reddish or yellowish*, and the smaller *green or blue*, without a single exception, among the many hundreds of such tinted couples now known."

Such an arrangement as this cannot be the result of chance, and unless all very distant stars are green or blue, it must be the result of physical connection. W. H. S. M.

As to the nearer stars being mostly double, Mr. Monck goes even further than I do in rejecting small parallaxes as doubtful. There are fourteen stars in Professor Young's list with parallaxes all considerably over a tenth of a second, which Mr. Monck does not take into account because their parallax has only been determined by one observer. Of these fourteen, eleven are single and only three are double stars. Facts such as these are best illustrated by presenting them to the eye, and I have therefore made a diagram showing the distance of twenty stars with large parallaxes. The parallaxes adopted for this purpose are those given in Professor Young's list, with the addition of some of Dr. Elkin's determinations. The diagram shows six of the seven stars referred to by Mr. Monck, but have been equally weighted, and the probable errors adopted by the observers are not taken into account. It will be seen that out of the twenty stars in the diagram, lying within a distance corresponding to a parallax of an eighth of a second, seven are double, one is a triple, and twelve are single. If we count the sun as a single star, the proportion which double and triple stars together bear to single stars is as two to three, in this small region of space. I admit that our list of doubles is probably still very imperfect, but our list of near stars is probably still more imperfect. If the stars are evenly distributed in space, we should expect to find seven times as many stars between the first and second concentric circles in the diagram as within the first circle, for the two circles correspond to spheres whose volumes are as one and eight, and there should be fifty-six times as many stars between the second and third circle as within the first circle, or seven times as many as within the sphere corresponding to the second circle. There is evidently

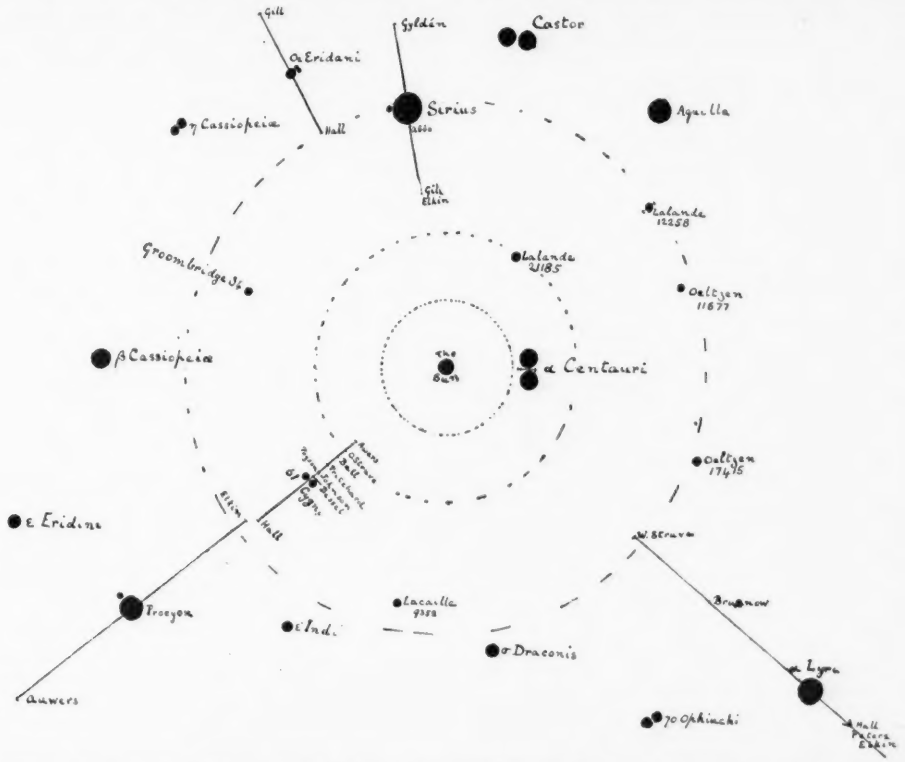


DIAGRAM SHOWING THE DISTANCES OF TWENTY STARS FOR WHICH LARGE PARALLAXES HAVE BEEN FOUND.

Aldebaran, with a parallax of 0″·116, would on the scale of the diagram have fallen outside the page. Mr. Monck's contention will not be affected by this, for I cannot count Aldebaran as a binary; there is no known physical connection between it and its minute companion 108″ off. The scale adopted is ten millimeters for the distance of a star with a parallax of one second of arc, or one millimeter for 20,626 radii of the earth's orbit.

Where there have been several determinations of the parallax of a star I have adopted a mean value, and have drawn a radial line indicating the range in distance corresponding to the various determinations.* All observations

* The short line through the place of α Centauri corresponds to the determinations of Henderson in 1842, 0″·913; Maclear in 1851, 0″·919; Moesta at Santiago in 1864, 0″·880; and Gill and Elkin in 1882, 0″·750. The short line through Lalande 21,258, corresponds to the determination of Auwers in 1863, 0″·262, and Krüger in 1864, 0″·230. The line through α Lyra should extend outside the diagram. Dr. Elkin has recently determined its parallax to be only 0″·034 ± ·045; Peter's determination in 1846 was 0″·103: and Hall's in 1881, 0″·134.

a great range in the real magnitudes of stars, and probably many small stars having large parallaxes have not yet been detected.

As to the colours of double stars, Mr. Monck rejects my facts and appeals to authorities; but in this instance I venture to differ with Sir John Herschel, who has, I think, been a little too sweeping in the statement that "no green or blue star of a decided hue has hitherto been found unassociated with a companion brighter than itself." The stars referred to in my note are all described as decidedly

blue by that careful observer, Dr. Gould, and they are all single stars. If Mr. Monck objects to my quoting instances from the southern hemisphere which he cannot verify himself, I will refer him to the striking case of Vega, which is a very blue star, and certainly has no companion brighter than itself. The small companion is also decidedly redder or lower in the spectrum than the principal star. I do not take such exception to Professor Young's statement, which, it should be noted, differs from Sir John Herschel's, for Professor Young confines his remark to double stars, and says that the smaller always lies higher in the spectrum. Vega is probably not an exception to this rule, as we do not know it to be double, and there is probably not any physical connection between it and its minute companion. But Sirius, which is an undoubted binary, is bluish-white, while its companion is reddish and cannot be described as higher in the spectrum than the principal star. The general law is, however, well worthy of remark, but we shall not lose by carefully noting the exceptions.

A. C. Ranyard.

Notices of Books.

The Blowpipe in Chemistry, Mineralogy, and Geology. By Lieutenant-Colonel W. A. Ross, R.A. Second Edition. (London: Crosby Lockwood & Son. 1889.)—Colonel Ross is an enthusiastic blowpipe manipulator, and has done much service in popularising blowpipe analysis. The book contains descriptions of many varieties of blowpipe apparatus and appliances, and it is satisfactory to find that the author recommends simple and cheap as opposed to elaborate apparatus. As an advocate of hand, foot, and reservoir blowers as compared with the ordinary mouth blowpipe, he will be welcomed by many who, with out-blown cheeks, have lost patience, time, and breath in vainly endeavouring to fuse a refractory assay. The theory of the blowpipe flame is dwelt on; we are told that it is a solid cone of flame, and the oxidising and reducing flames of our youth are banished in favour of "oxyhydrogen" and "hydrocarbonous pyrocones" respectively, whilst our coloured blowpipe flames become "pyrochromes," a phraseology which contrasts curiously with the simplicity of the apparatus he recommends. That excellent and useful introduction of the author's—the aluminium plate support—is described, and its application to blowpipe assays explained. Many tables of rocks, minerals, ores, silicates, &c., showing their composition and their behaviour before the blowpipe, are interspersed through the book, and will be found useful. Whilst admiring the author's enthusiasm for the methods he has elaborated, we think that for purposes of instruction a terser style would have been better. The specific gravitometer, which he describes on p. 116, cannot be recommended, for one reason among others, the air cannot be satisfactorily expelled from the little box containing the gold dust, &c.

A Text-book of Elementary Metallurgy. By Arthur H. Hiorns. (Macmillan & Co. 1888.)—This little work has been arranged to meet the requirements of pupils preparing for the elementary stage of the Science and Art Department's examinations in metallurgy. In the first three chapters, which are more or less introductory, the technical terms in general use are defined and a description is given of the nature and properties of fuel. The usual methods of extracting the useful metals from their ores are explained, and sectional drawings of the various furnaces are given, as well as explanations of several iron and steel processes—Freibeg's process for silver, and the Welsh methods for copper. The book is written in a clear and simple manner, and can be recommended as a valuable addition to our elementary manuals.

Celestial Motions; a Handy Book of Astronomy. By W. T. Lynn, B.A., F.R.A.S. Sixth Edition. (London: E. Stanford.)—The fact that in five years Mr. Lynn's little treatise has gone through as many editions is a proof of its popularity with the scientific public. There are many decided improvements in the present edition, the work has been considerably enlarged, a chapter on the Calendar added, and the eight pages giving a list of the asteroids have been omitted, we think with advantage. Perhaps some reference to more recent investigations on the proper motion of the solar system than those of Airy and Dunkin might have been introduced, at least some notice should have been taken of Ludwig Struve's recent researches, based on the proper motions of more than 2,500 stars. The results of Peters's and Elkin's determinations of the parallax of Capella give a far smaller parallax than 0″·3, Elkin giving 0″·11 and Peters 0″·07, corresponding to thirty and seventy-one light years respectively, while Struve's value gives a distance of only eleven light years. But with these exceptions, Mr. Lynn's work appears to be very carefully and accurately brought up to date.

*Chambers's Encyclopædia.**—These volumes swell the evidence that Messrs. Chambers follow with unslackening zeal the traditions of their house in its honourable distinction of supplying high-class "information for the people" at a price which brings it within the means of the cottager. Our general survey—for only this is possible—of the articles in these instalments of a work the completion of which we await with eagerness justifies us in saying that the lofty standard of the first volume is maintained, and that where the articles may need revision, this will be only in virtue of that advance in knowledge which makes periodical recasting of all encyclopædic works necessary. Many of the articles, notably the biographical, will escape this, since their crisp presentment of facts and sound assessment of their several subjects render them final and complete. Mr. Davidson's general remarks under the head "Biography" are sound and discriminating, except where he gives even qualified commendation to that worthless piece of slop-work, Trollope's "Life of Thackeray;" and among the more admirable articles of the kind we may note Sir Geo. Grove's "Beethoven," Whyte's "Boccaccio," Andrew Lang's "Burns," with that undue prominence of the warts and wrinkles of the man which is also given in the "Letters to Dead Authors," Ornsby's "Cervantes," and Grant Allen's "Darwin." The article on "Buddhism" has been subjected to needful revision, the exposition of the doctrines of *karma* and *nirvana* being as clear as the obscurity of those theories permits. *Nirvana* is defined as including other ideas than those of annihilation, corresponding, as Rhys Davids has shown, to the Pauline "peace of God which passeth understanding." The biological articles, as might be expected from their writer's attainments, are masterpieces of lucidity and exactness, and it is surprising that under such limitations of space as the work imposes, Mr. Patrick Geddes should have contrived room for dainty and suggestive paragraphs such as the following, which adorns the article on "Botany." Speaking of the narrowing influences of mere fact-collecting, apart from care as to the significance of the things collected, he says:—

> The highest modern botany neither harvests plants with the herbalist, nor picks them to pieces with the child, but finds alike its rise and climax in watching the blossoms open and the bees come and go. The pedigree of the science is only on one side, from the

* Vol. II. Bea to Cata. Vol. III. Cata to Dion. (London and Edinburgh: W. & R. Chambers, 1888–1889).

herbals of Dioscorides and Brunfels to the system of Linnæus or Jussieu; the other and nobler line rises in Virgil's song of living nature, runs through the keen yet simple records of naturalists like those of Selborne and Walden, and culminates in the monumental volumes of the greater naturalist of Down. It is in the school, or rather garden, of Darwin, viewed both as the last of the old-world naturalists, and as the first of evolutionists and physiologists, that our modern "introduction to botany" must begin; studies in the herbarium of the systematist and the special laboratories of the physiologist, anatomist, and microscopist may follow thereafter as occasion requires. For the age of mere analysis, guided only by the love of incessant novelty, or even by that of unity amid details, is ending; the student may now approach the service in a new spirit, since he can interpret its literature as but the incipient record of that vast drama of the evolution of life at which it is his rare good fortune to be an awakening spectator.

In his summary of the "Darwinian theory," Mr. Geddes refers too briefly to the existing differences between the neo-Lamarckian school, to which Herbert Spencer is lending his support, and the school of which Professor Weismann is the chief representative, and which contends that the theory of the inheritance of acquired characters is not needed to explain the phenomena of the organic world—in other words, that changes acquired by the individual are never transmitted. We may, however, look for a full discussion of this when the article on "Evolution" is reached. Among the historical articles, we may call special attention to that on the "Celts" from the competent pen of Professor Rhys, who, with his true sense of historic continuity, deals with the persistence of pre-Celtic non-Aryan races and their influence in divers ways upon later settlers. The maps and woodcuts throughout these volumes are perfect in their clearness, and we hope that an undertaking into which the best workmanship possible is put will meet with the success which such efforts deserve and seldom fail to win.

ED. CLODD.

Notes.

THE June number of *Harper's Magazine* contains an interesting article by Professor George Darwin on the planet Saturn and his ring system.

AT a recent meeting of the Meteorological Society, Mr. W. H. Dines gave an account of some experiments made to investigate the connection between the pressure and velocity of the wind. The pressure plates were placed at the end of the long arm of a whirling machine which was rotated by steam-power. Experiments were made with about twenty-five different kinds of pressure plates. The pressure upon a plane area of fairly compact form is about $1\frac{1}{2}$ lbs. per square foot at a velocity of 21 miles per hour; and as the pressure varies with the square of the velocity, a pressure of 1 lb. per square foot is caused by a wind of a little more than 17 miles per hour. The pressure upon the same area is increased by increasing the perimeter. The pressure upon a $\frac{1}{4}$-foot plate is proportionally less than that upon a plate either half or double its size. The pressure upon any surface is but slightly altered by a coue or rim projecting at the back—a cone seeming to cause a slight increase, but a rim having apparently no effect.

What causes the blue flame produced when salt is thrown into a coal fire? This is a question that is frequently asked, and has been answered many ways. It must be remembered that salt or sodium chloride consists of only two elements—sodium and chlorine. Sodium is known to be the great producer of yellow flame, and therefore it is quite reasonable to suppose that the chlorine has to do with the blue flame. Some recent experiments by Mr. N. Leonard support this view. He shows that the blue flame is also produced by some other metallic chlorides, but that it is not produced by other compounds of sodium. It is further demonstrated that certain compounds of chlorine containing carbon, such as chloroform, chloride of carbon, &c., also produce a blue flame when thrown in the fire. This has led to the conclusion that when salt is thrown on a coal fire, the chlorine forms a compound or compounds with the carbon in the coal, which by decomposing gives rise to the blue flame. This conclusion finds support in the fact that when salt is thrown on to a red-hot body containing no carbon, platinum for instance, the blue flame is not produced.

A VALUABLE LIBRARY.

In a street leading from Chancery Lane into Staple Inn is an institution which deserves to be better known. It is the free scientific library of the Patent Office. Mounting a high staircase you enter a hall with a series of bays on either side. In these, and in adjoining rooms, there are nearly 100,000 volumes arranged by subjects under the headings—Chemistry, Physics, Astronomy, Biology, Agriculture, Metallurgy, and so on. The visitor, after merely writing his name and address in a book at the door, is free to go anywhere, and take down any book he likes. The library is particularly rich in scientific periodicals, both English and foreign. The current numbers are laid out for inspection on two large tables, an advantage which the reader at the British Museum does not enjoy. The number of visitors to the institution shows rapid increase, especially since the hour of closing was made 10 P.M. instead of 4. The librarian reports that there were 80,000 readers last year.

THE FACE OF THE SKY FOR JUNE.

BY HERBERT SADLER, F.R.A.S.

SPOTS of any size are still of very rare occurrence on the sun's disc. During the month of June there will be no real night throughout the British Islands. On the morning of the 28th there will be an annular eclipse of the sun, which, however, will not be visible at Greenwich. The line of central eclipse enters Africa, near Walfisch Bay, on the west coast, and crosses the southern portion of the Continent till just south of the river Rovuma on the east coast; after that its track is entirely across the Indian Ocean. Minima of the Algol type variable δ Libræ (cf. "The Face of the Sky for April") occur on the 3rd at 10h. 7m. P.M., on the 10th at 9h. 41m. P.M., on the 15th at 9h. 15m. P.M., and on the 24th at 8h. 50m. P.M. Mercury sets nearly one hour and three-quarters after the sun on the 1st of the month, with an apparent diameter of $9\frac{1}{3}''$, and a northern declination of $24\frac{1}{4}°$, and will be fairly well placed for observation during the first week in June. After that he rapidly approaches the sun, coming into inferior conjunction at 11h. A.M. on the 19th. Subsequently he becomes a morning star, but rises in very bright twilight. He does not approach any naked-eye star very closely. Venus is a fine object in the morning sky, being at her greatest brilliancy on the 6th. On the 1st she rises at 2h. 28m. A.M., having an apparent diameter of 42″, and a northern declination of $11\frac{1}{2}°$. On the last day of the month she rises at 1h. 30m. A.M., 2h. 18m. before the sun, with a northern declination of 15° 20′, and an apparent diameter of 24″. On the morning of the 11th she will be very close to the 6th magnitude star 31 Arietis. Mars is absolutely invisible, being in conjunction with the sun on the morning of the 18th. Owing to his extreme southern declination, below 23° south throughout the month, Jupiter, though he comes into opposition

with the sun on the 24th, is not at all well situated for observation in these latitudes. He rises on the 1st at 9h. 51m. P.M., and on the 30th at 7h. 40m. P.M., his apparent diameter on the last day of the month being $46\frac{1}{2}''$. The following phenomena of the satellites occur between the time of the planet's being 8° above the horizon and midnight, G.M.T., on the days named. At 11h. 14m. P.M. on the 5th an ingress of the shadow of the first satellite, and at 11h. 41m. P.M. an ingress of the satellite itself. At 11h. 16m. P.M. on the 6th a reappearance from occultation of the same satellite. At 11h. 11m. P.M. on the 9th an egress of the second satellite. At 10h. 30m. 9s. P.M. on the 13th an eclipse (disappearance) of the first satellite. At 10h. 30m. P.M. on the 15th an egress of the shadow of the third satellite, and at 11h. 23m. P.M. an egress of the satellite itself. The satellite should be watched for change of brightness before egress. At 10h. 24m. P.M. on the 16th an ingress of the shadow of the second satellite, followed at 10h. 47m. P.M. by an ingress of the satellite itself. At 11h. 47m. P.M. on the 21st an egress of the shadow of the first satellite, and four minutes later an egress of the satellite itself. This transit should be carefully watched, as the satellite may be projected on its shadow. This will be a very good opportunity for observing whether the shadow is larger than it ought to be, as has been stated by some observers. (See Webb's "Celestial Objects.") On the 22nd, at 11h. 35m. P.M., an ingress of the shadow of the third satellite, and at 11h. 47m. P.M. an ingress of the satellite itself. This phenomenon should be observed for the reasons given above. On the 25th a reappearance from eclipse of the second satellite at 9h. 47m. 38s. P.M. On the 28th an ingress of the first satellite at 11h. 18m. P.M., and of the shadow at 11h. 24m. P.M. Here again the phenomenon of projection may occur. On the 25th there is a predicted eclipse of the fourth satellite, which is computed to disappear at 8h. 48m. and reappear at 9h. 55m.; but there will probably be no *real* eclipse, the satellite remaining visible as a speck of light in good telescopes. In any event it will just skirt the edge of the shadow, and any irregularities in its brightness due to clouds or inequalities of absorption in the atmosphere of Jupiter should be noted. At 10h. 59m. 35s. on the same evening there will be a reappearance from eclipse of the first satellite. Jupiter describes a short retrograde path in Sagittarius, but does not pass very near any naked-eye star. Saturn is still visible, but must be looked for very early in the evening to be seen to any advantage. On the 1st he sets at 11h. 12m. P.M., and on the 30th at 10h. 19m. P.M., his apparent diameter at that date being 16″. He describes a short path through Cancer into Leo. Uranus rises on the 1st at 2h 56m. P.M., and on the 30th at 1h. 0m. P.M. He describes a very short retrograde path in Virgo, to the S.W. of θ Virginis. Neptune is invisible. There is no well-marked shower of shooting stars in June, owing probably to there being no real darkness during the whole month. The moon enters her first quarter at 8h. 2m. P.M. on the 6th, is full at 1h. 58m. P.M. on the 13th, enters her last quarter at 7h. 35m. A.M. on the 20th, and is new at 8h. 54m. A.M. on the 28th. There will only be one occultation visible—and that can hardly be said to be visible—at Greenwich during June. The 6th magnitude star B.A.C. 5758 will disappear at 3h. 44m. on the morning of the 13th, at an angle of 98° from the vertex, the moon being setting at the time; the reappearance will occur while the moon is below the horizon. At 11h. 26m. P.M. on the same evening there will be a near approach of the 6th magnitude star B.A.C. 6088, at an angle of 161° from the lunar vertex. At 2h. 34m. on the morning of the 20th there will be a near approach of the 5th magnitude star 30 Piscium, at an angle of 173° from the vertex.

Whist Column.

By W. MONTAGU GATTIE.

AMERICAN LEADS.

(*Continued from page* 155.)

IN our last article we gave a brief explanation of the system of American leads; and, in pointing out the scientific uniformity of practice which it is aimed to establish, we, so to speak, stated the case of its supporters. It was originally our intention to proceed at once to consider the objections which have been urged against the system by its opponents, among whom are several distinguished players. But we have, in the meantime, received a letter, which we publish below, raising an interesting point in connection with the lead of the "penultimate," or lowest but one, from a five-card suit, which, as we have already seen, is a particular case of the first maxim of the American code; and, as we imagine that the illustrative hand furnished by our correspondent will, in the view of most of our readers, agreeably vary the monotony of theoretical discussion, we propose to defer reviewing the arguments of the opposing school till next month, when we shall also have something to say as to the extent to which the system is applicable to trumps.

We have already pointed out that circumstances may frequently arise in the course of a hand, under which it becomes necessary to modify or altogether to abandon any rule for leading. It will be seen that Mr. Hughes adduces a case which, in his opinion, justifies a departure from the penultimate lead; and, although we are not at present prepared to admit this contention, the question certainly affords fair ground for discussion.

To the Editor of KNOWLEDGE.

SIR,—I shall be glad of your decision as to the correct lead of trumps by a player holding five, when his partner has called.

The ordinary lead of the penultimate is—at any rate occasionally—open to the objection that the player's partner may be able to place the lower trump in his hand, and thereby infer that he has led from two trumps only.

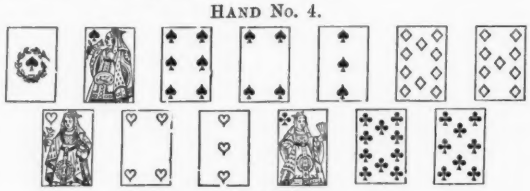
In the accompanying hand, which occurred in actual play, Z turned up the 2 of spades, and his lead of the 5 caused Y to infer that he had only the trump card remaining. Y therefore finessed ace, queen, although B's play had shown that he could take a certain ruff in clubs.

In my opinion, in answer to a call, the lead of the lowest trump, showing four or one, is more advantageous than the lead of the penultimate, and I should like to know whether this point has been discussed by the authorities on whist.—I am, sir, yours faithfully,

FRANK S. HUGHES.

Westminster: May 10, 1889.

HAND No. 4.

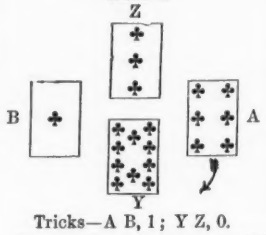


Y's Hand.

Score—A B, 0; Y Z, 1. Z turns up the 2 of Spades.

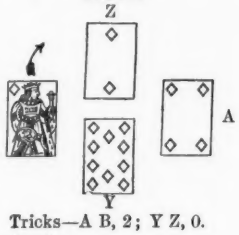
NOTE.—A and B are partners against Y and Z. A has the first lead; Z is the dealer. The card of the leader to each trick is indicated by an arrow.

Trick 1.



Tricks—A B, 1; Y Z, 0.

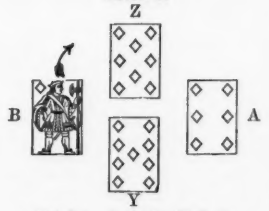
Trick 2.



Tricks—A B, 2; Y Z, 0.

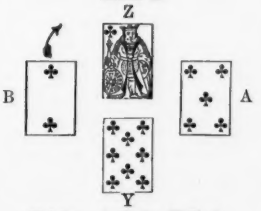
NOTE.—Y commences a "call" in both suits.

Trick 3.



Tricks—A B, 3; Y Z, 0.

Trick 4.



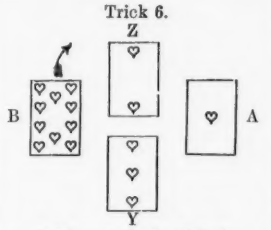
Tricks—A B, 3; Y Z, 1.

NOTE.—*Trick* 3.—B has shown four honours in diamonds, and therefore Z has no more diamonds. Y completes his call for trumps. *Trick* 4.—B has no more clubs; for A has shown five originally, and therefore has three remaining; and B cannot hold the other one (viz. the 4) or he would have returned it, instead of the 2. Therefore Z has the 4, and B will be able to make a trump on the third round of the suit.

Trick 5.

Tricks—A B, 4; Y Z, 1.

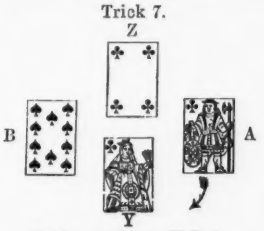
Trick 6.



Tricks—A B, 5; Y Z, 1.

NOTE.—*Trick* 5.—Z having turned up the 2, Y naturally infers that the 5 is his best, and therefore finesses.

Trick 7.



Tricks—A B, 6; Y Z, 1.

Tricks 8 to 13 are won by YZ, who score

THE ODD TRICK AND TWO BY HONOURS, AND AB SAVE THE GAME.

A's Hand.	B's Hand.	Y's Hand.	Z's Hand.
S.—7.	S.—Kg, 10.	S.—A, Q, 6, 4, 3.	S.—Kn, 9, 8, 5, 2.
D.—7, 6, 4.	D.—A, Kg, Q, Kn, 5, 3.	D.—10, 9.	D.—8, 2.
C.—Kn, 9, 7, 6, 5.	C.—A, 2.	C.—Q, 10, 8.	C.—Kg, 4, 3.
H.—A, 9, 8, 7.	H.—10, 6, 5	H.—Q, 4, 3.	H.—Kg, Kn, 2.

Remarks—Many players who adopt the lead of the penultimate from plain suits of five cards prefer to open with the lowest of five trumps. But, whether they are right or wrong in this, it can scarcely, we think, be maintained that the foregoing hand furnishes any substantial argument in support of the one course or in opposition to the other. Y, no doubt, was led to think that his partner had only the 2 of trumps remaining, and therefore finessed his queen; whereas, if he could have divined the actual state of affairs, he would have played his ace, and by continuing with a second round of trumps would have secured the game. But, if Z had led the 2, as Mr. Hughes proposes, would Y have been justified in playing his ace, on the chance that the lead was from four, notwithstanding the opposing strength in diamonds and his want of information as to hearts? After trick 4, it is clear to Y that Z has eight cards which are either hearts or trumps; and it may be urged that the chance of his holding seven hearts and one trump is less than the chance of his holding six hearts and two trumps. But in either case it would, in our opinion, be highly imprudent for Y to give up the command of trumps. Even as it is, with five trumps to the knave in Z's hand, it would not be difficult to find cases in which Y would miss the game by not finessing the queen; and, without positive information as to Z's strength, it would be quite contrary to principle not to finesse, seeing that the lead is in response to a call. It is worth noticing that some players with Z's hand would have also called for trumps; and, if Z had done so, Y would have been in no doubt as to the meaning of his lead at trick 5.

ELEMENTARY EXPLANATION OF THE PLAY.

Trick 1.—A opens his longest suit, and leads the lowest but one from five; Y commences to call for trumps by playing the 10 as second player, although he holds the 8; B of course plays his ace; and Z, as he is not disposed to call for trumps, plays his smallest club.

Tricks 2 *&* 3.—B's is the correct lead from a suit headed by all four honours. Y calls for trumps by playing the 10 of diamonds before the 9. Z and A play their lowest cards to each trick; and, as B's lead shows that he holds ace and queen, it is clear that Y and Z have no more diamonds—*i.e.*, that all the remaining diamonds are with A and B.

Trick 4.—If B could now force Y, who has shown great strength in trumps, by continuing the diamond suit, it would be good play to do so; but, as Y and Z are both known to be void of diamonds, he would enable the weaker hand to trump and the stronger hand to discard some losing card. He therefore rightly prefers to return his partner's lead. Z of course puts on the king; and A, by playing the 5 after having led the 6, shows that he held five clubs originally. Y and Z, each of whom has one club remaining, are able to infer that B has no more, for he could only have one other, and, if he had had that, he would have returned it instead of the 2, in accordance with the rule to return the highest of two remaining of partner's suit.

Trick 5.—Z having obtained the lead, seizes the opportunity to get out the trumps, and, having five of them, leads the penultimate. Y very properly finesses against the king, which is as likely to be with A as with B.

Trick 6.—For the same reason as before, B avoids continuing the diamonds, and opens hearts in the hope that his partner may get in and give him a chance of ruffing clubs. He leads the 10 as being the best of a three-card suit. As Z holds king and knave himself, he knows the lead is not from king, knave, 10, and he is perhaps justified in assuming it to be (as it is) from weakness. It would, however, have been better play to put on the knave, under the circumstances, in case B should have led from ace, queen, 10.

Trick 7.—A knows from his partner's lead at Trick 4 that he has either queen and 4 of clubs or no more. In the latter case Y and Z must each have one of the suit; for, if Z had held the queen, he would have played it instead of the king at Trick 4; and, if Y had held the 4, he would have "called" with 8 and 4 instead of with 10 and 8. A therefore takes the best chance of saving the game by continuing the clubs.

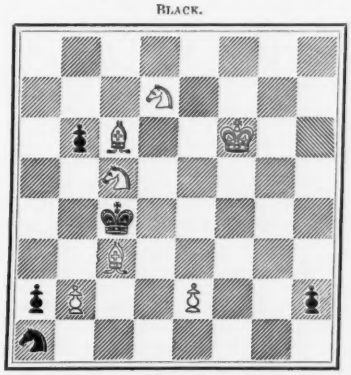
The remaining tricks obviously fall to Y and Z, as the student will see at once on dealing out the hands given above.

Chess Column.

[Our Chess column has been placed in the hands of Mr. R. F. Fenton during the absence of Mr. Gunsberg, who has gone to play at the International Chess Tournament in New York. Mr. Gunsberg will probably return early in June.—EDITOR.]

PROBLEM BY C. A. L. BULL.

BLACK.



WHITE.

White to play and mate in three moves.
White, 7 pieces; Black, 5 pieces.

THE NEW YORK INTERNATIONAL CHESS CONGRESS.

The second round of the tournament is on the eve of completion, and before our time of going to press will be definitely decided. There have been many vicissitudes of fortune in the course of the protracted and exhausting struggle. For a long time Herr Max Weiss, the leading player of Vienna, held the lead, then M. Tschigorin, the Russian champion, just got in front and remained there, and at one stage Mr. Amos Burn, of Liverpool, well known for the strength and safety of his play, held the first place; neither must we forget that the English champion, Mr. J. H. Blackburne, has borne himself bravely in the fray, and always maintained a prominent position, together with S. Lipschutz, the young New York champion, who by excellent and consistent play has greatly increased his budding reputation.

At some distance from the above we find the well-known names of James Mason, Max Judd, J. W. Showalter, Eugene Delmar, and the veteran H. E. Bird, whose score would have been higher, had he not been obliged to forfeit a game by illness.

The position of Mr. Gunsberg on the score sheet will be a matter of congratulation to his friends, and particularly so when it is remembered that he was suffering for some days with a cold and sore throat that at one time threatened to assume a dangerous aspect. It will be convenient here to give the names of the several contestants and a summary of the games played, together with the games yet to be decided. A closer and more interesting finish we never remember. It will be seen that Max Weiss can still win the first prize by beating J. Mason, but if he is defeated he will tie with Mr. Gunsberg for the second prize, also that Messrs. Burn, Blackburne, and S. Lipschutz, can either win or tie in their scores.

SCORE INCLUSIVE OF SATURDAY, MAY 18, PLAY.

J. W. Baird	6 games	To play	D. Baird and G. Gossip.
D. G. Baird	16 „	„	J. W. Baird.
H. E. Bird	17 „	Played all.	
J. H. Blackburne ...	26 „	To play	A. Burn.
C. F. Burille	14 „	„	S. Lipschutz.
Amos Burn	26 „	„	J. H. Blackburne.
E. Delmar	17½ „	„	M. Taubenhaus.
G. Gossip	13 „	„	J. W. Baird.
J. Gunsberg	28½ „	Played all.	
J. H. Hanham ...	14 „	To play	S. Lipschutz.
Max Judd	19 „	„	C. F. Burille.
S. Lipschutz	24½ „	„	J. Hanham and W. Pollock.
D. M. Martinez ...	13½ „	Played all.	
J. Mason	20½ „	To play	Taubenhaus and Tschigorin.
N. MacLeod	5½ „	Played all.	
W. Pollock	16½ „	To play	Max Judd.
J. W. Showalter ...	18 „	Played all.	
M. Taubenhaus ...	16½ „	To play	E. Delmar and J. Mason.
M. Tschigorin ...	29 „	Played all.	
Max Weiss	28½ „	To play	J. Mason.

The following game was played on the 10th instant in the second round, and resulted in a draw; the game in the first round between the same opponents was won by Mr. Gunsberg:—

GIUOCO PIANISSIMO.

WHITE. J. Gunsberg.	BLACK. M. Tschigorin.	WHITE. J. Gunsberg.	BLACK. M. Tschigorin.
1. P to K4	P to K4	15. P to QKt4	B to Kt3 (*c*)
2. Kt to KB3	Kt to QB3	16. Kt to B4	P to K5
3. B to B4	B to B4	17. R to R3	Q to B4
4. P to Q3	Kt to B3	18. P × P	Q × P
5. Kt to B3	P to Q3	19. R to QB3	B to Q5
6. B to KKt5	B to K3	20. Kt to Q2	Q to K2 (*d*)
7. Kt to Q5	Kt to R4 (*a*)	21. R to KB3	Q to K7
8. B to Kt3	Kt × B	22. P to B3	B to Kt3
9. RP × Kt	B × Kt	23. P to QKt3	R to K2
10. P × B	P to R3	24. P to Kt3 (*e*)	KR to Ksq
11. B × Kt	Q × B	25. K to Kt2	R to K6
12. Castles (*b*)	Castles	26. Q × Q	R × Q
13. Kt to Q2	Q to Kt3	27. Kt to B4	R to R7
14. K to Rsq	QR to Ksq	28. Kt × B	RP × Kt

And the game in a few moves was abandoned as drawn.

NOTES.

(*a*) The best way apparently of neutralising Mr. Gunsberg's novel attack of Kt to Q5.

(*b*) Although White has the disadvantage of a doubled Pawn, he is quite compensated by remaining with a Knight against a Bishop.

(*c*) If he had taken the offered Pawn, he would of course have lost the QRP, and have been left with slightly the worst of the position.

(*d*) Taking the QP would have been followed by R to Q3 with damaging effect.

(*e*) But for this precautionary move, M. Tschigorin would soon get an advantage by a favourable exchange of Queens.

Since the above was in type the Tournament has come to a conclusion. Max Weiss and M. Tschigorin tie for the first and second prizes with 29 games each, J. Gunsberg wins the third prize with 28½ games, and J. H. Blackburne the fourth with 27 games, the other three prizes fall to A. Burn with 26 games; S. Lipschutz, 25½ games; and J. Mason, 21 games, in the order named.

The tie between Max Weiss and M. Tschigorin for first and second prizes will be played off under the following conditions embodied in Rule 4 of the Tournament:—"If two players tie for the first prize, they shall play a match for the first winner of two games, exclusive of draws; but after four draws the match shall terminate; and if the score be even, the prizes shall be divided; but if either player shall be a game ahead, he shall be declared the victor."

CITY OF LONDON CHESS CLUB.

In the match between Messrs. Block and Loman of seven games, Mr. Block has won 1, drawn 2, and lost 0. The great winter tournament is nearly over, Mr. Serraillier leading, having won 7 out of 8 games, and has only Mr. Loman to play. Mr. Kenning, however, may tie him, who has won 6 out of 8 games, and who has also to play Mr. Loman. Mr. A. C. Smith has finished all his games with a score of 6½, and Mr. Loman has scored 4 with 2 yet to play. Mr. Rottjer, who had begun well, had to retire, owing to absence from London, and the same remark applies to Mr. Tarry. The spring handicaps have been commenced. In the first Messrs. Block, Morian, and Dr. Smith have won all their games played, and Mr. Herbert Jacobs 3 out of 4. In the second Mr. E. O. Jones, who has lately been raised to the first class, and Mr. Woon have each won their 4 games played. For the third the Rev. J. Watson has won 4 games out of 5, and Mr. Latham 3 out of 4.

NORTH LONDON CHESS CLUB.

The annual dinner of this important club was held at the London Tavern, Fenchurch Street, on the 9th inst., and was a great success, over seventy members and friends gathering round the table. Dr. Hunt, the president, was in the chair, and the treasurer, Mr. T. R. Howard, and Mr. C. E. Biaggini, the hon. secretary, occupied the vice-chairs. The visitors included Messrs. Clarke, Fenton, Gastineau, and Ridpath (City C.C.), Messrs. Carr, Peachey, and Schlesinger (Athenæum C.C.), Wallace (London Banks), Johnson (Blackfriars), E. Marks and Dr. Greenwood (Hornsey Rise), and Messrs. Biner and Kistruck (Shoreditch). It had been arranged that speeches should be conspicuous by their absence, so after the usual loyal toasts, Mr. Clarke, president of the City Club, proposed "Success to the North London, and the health of its President," which was responded to in a happy vein by Dr. Hunt.

ANSWERS TO CORRESPONDENTS.

ARTHUR GREATOREX.—It is an interesting end game, but the poor Black is in such a woeful minority of force that he must lose any way.

JAMES PAUL.—Your solution of M. Grosdemange's ingenious problem is correct.

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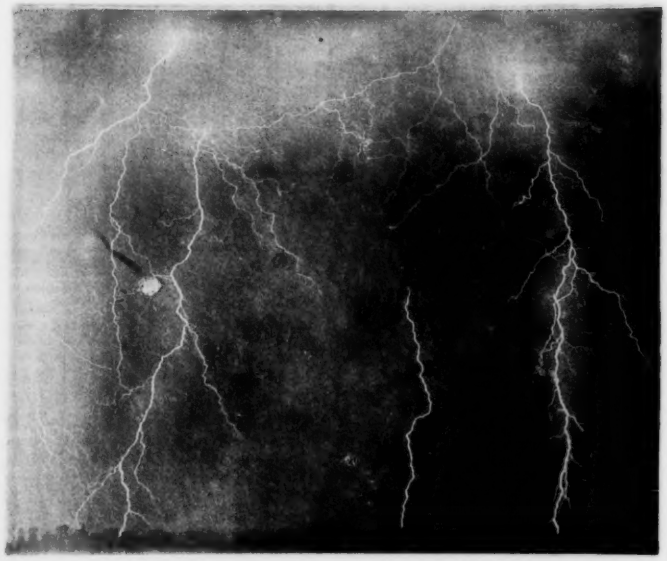
XUM

1. Taken at Balham on 6th June, 1889, by G. J. NINNES, looking S.E.

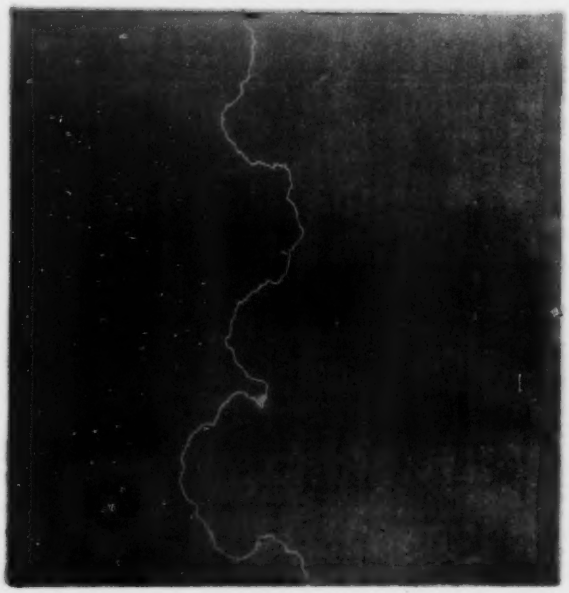
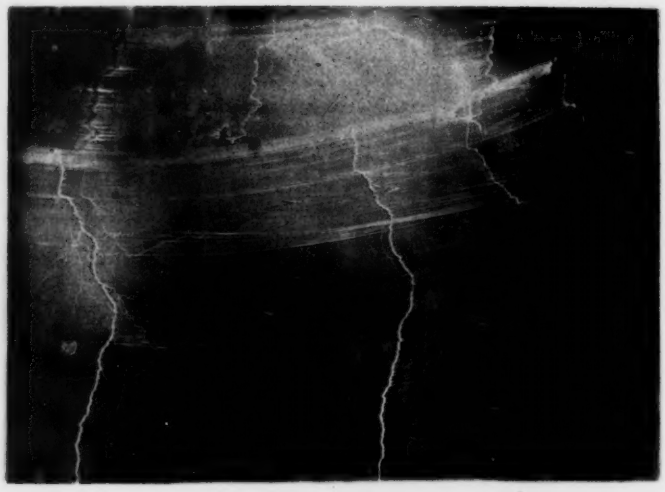
2. Taken at Balham on 6th June, 1889, by G. J. NINNES, looking S.E.

3. Taken at Sydenham on 6th June, 1889, by J. POFFER. Camera facing nearly East.

4. Taken at Ilford, Essex, on the 6th June, 1889, by E. A. GOLLEDGE.



5. Taken at Balham on 6th June, by G. J. NINNES, looking S.E., 1889.



6. Taken at Ealing, on 6th June, 1889, by Dr. H. H. HOFFERT, D.Sc.